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THE CLIMATE OF PORTUGAL

AND

Notes on its Health Resorts

BY

DR. D. G. DALGADO,
of the Academy of Sciences of Lisbon.

WITH SIX MAPS AND NUMEROUS TABLES.

PUBLISHED BY ORDER.

LISBON.
1914.

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PREFACE.

Nature is the healer of diseases.
HIPPOCRATES: *On Epidemics.*
B. VI., Sect. 5., § 1.

At no period in the history of the world did more people travel in search of health and repose than at the present, so that an accurate knowledge of the climatic and other health resorts in various countries becomes, day by day, a very important matter. The polypharmacy of fifty years ago is being likewise replaced, more and more, by *vis medicatrix naturæ* and by physio-therapeutics, so that not only are the climatic resorts, the spas, and sea-baths more extensively utilised now than ever before, but also other physical agents, such as electricity, sunlight, radioactivity, claim a good deal of attention.

The object of this book is twofold: firstly, to give a sketch of the climate of Portugal as a

whole; and, secondly, to describe briefly its principal health resorts. The study of the first gives a clue to a general knowledge of the second; and an accurate knowledge of the second leads to the full comprehension of the first.

The climate of Portugal, in its medical aspect, has not yet received that amount of attention to which it has a just claim. Its description in this book is based upon a natural principle. In his Introduction to *Bartholomew's Atlas of Metereology*, Dr. Buchan remarks: «Since the relative distribution of pressure determines the direction and force of the prevailing winds, and these in their turn the temperature, moisture, cloud, rainfall, and sunshine, and in a very great degree, the surface currents of the ocean, it is evident there is here a principle applicable not merely to the present state of the earth, but also to different distributions of land and water in past times». An attempt is made, for the first time, to study, under the guidance of this principle, the present state of the Portuguese climate. For this purpose, the whole country, including the «adjacent» islands of the Azores and Madeira, is divided into six regions, based upon the influence of the different prevailing winds; and it is explained:

how each of these winds regulates the distribution of the principal climatic factors and determines the climate of each region; how the climate of each region modifies its flora, and how the flora of each region forms a guide to its climate; how the climate of each region influences the physiological functions and the pathological processes in its respective inhabitants; and how each region can be utilised in the preservation and improvement of health, and in the cure of disease. It is pointed out likewise: how the Portuguese regional winds bring down the line of junction of the polar and the equatorial climates, on the western coast of Europe, from the latitude of 45° degrees to that of between 38° and 39°; how these winds modify the course of the Gulf Stream in winter and in summer; and, lastly, how, due to the same winds and the Gulf Stream, a portion of the western coast of Portugal has the most temperate, the most constant, and the most equable climate of the entire Continent.

The whole subject is no doubt intensely interesting, but it is likewise very vast and extremely complex. Its full and thorough examination demands many statistical and other details which are not yet available. This defect is not

peculiar to Portugal, but noticeable, in varying degrees, in all other countries. In the description of the climate care has been taken to eschew, as far as possible, discussions of the principles of general climatology, principles which can be better studied in works specially devoted to the subject. An effort has been made to be as concise as possible, without omitting any important facts.

The health resorts of Portugal consist of three great groups: the climatic, the mineral-water and the sea-bathing. Compared with the size of the country, they are very numerous. In these pages. only those are described which are, or which can be rendered, useful to a foreigner. In order to define clearly the nature of each climatic resort, a head-note has been framed, whenever the details are available, stating the class, the species, and the type or types to which it belongs, in accordance with a classification based mainly upon winds and breezes.

This book is written in English for two reasons: firstly, because the number of English-speaking people is far greater than the Portuguese-speaking; and, secondly, because it is the English-speaking people who travel most in search of health or of pleasure, and it is they, also, who take more

interest in the climatic and other health resorts. If a large number of English, French, and German works on the health resorts of Europe or of the World, published during the last 50 years, be consulted, it will be seen at once how, if Madeira be excluded, almost all of them make no mention of any resort in Portugal. This is not just to the country on the one hand, and it is a sensible loss to the foreign invalid on the other. Nothing will, therefore, give me greater pleasure than to know, that this book has contributed, in some small measure, to make the Portuguese climate and the Portuguese health resorts more widely known, and their merits duly appreciated. I may mention that I have no material interest, direct or indirect, of any kind or nature, in any of the places described in these pages. My interest is purely scientific. I have devoted to the subject considerable time and labour.

When a medical man has made himself well acquainted with the climatic resorts and spas of various countries, his power of treating his patients is considerably increased. Unfortunately the principles underlying the study of these subjects have not yet made much progress. Those who are conversant with the works of

Hippocrates, Celsus, Pliny, and other medical classics, see at once how these authors still dominate the sciences of climatology and balneology; and how slow and how small has been the advance, in the principles of these sciences, during the last two thousand years. I hope to be excused if I make sometimes references to their writings, for it is the fashion now-a-days not to do so.

In the preparation of this work I am indebted to several modern authors, whose works have been quoted at the close of each chapter. Here I wish to acknowledge my thanks to Sr. Ferrugento Gonçalves, of the Meteorological Observatory in Lisbon, to Sr. Adriano J. Lopes, of Coimbra, to Prof. Mattozo Santos, and to many other officials and friends who have freely and willingly supplied valuable information.

My thanks are also due to Dr. V. P. de Sá for going through the manuscript and for making some useful suggestions; to Prof. S. Rodolfo Dalgado for helping me very greatly in correcting the proof-sheets; and to Sr. Candido A. Nazareth, the Head of the printing Department of the Coimbra University Press, for getting this work set in type, in the best way possible, by compositors not knowing a single word of English.

For the publication of this book I am indebted to the Academy of Sciences of Lisbon. I wish to tender here my grateful thanks to Sr. Almeida Lima, the accomplished Professor of Physics and Director of the Meteorological Observatory in Lisbon, for describing this book as «a most interesting result of an assiduous study of a difficult subject», and recommending its publication by the Academy; to Prof. Pina Vidal, Dr. Vergilio Machado, and Dr. Silva Amado for seconding the proposal; and to the illustrious Academy for conferring upon me, for the second time, the honour of its *placet*.

Mont'Estoril, 5th December, 1913.

D. G. D.

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ABBREVIATIONS AND MEANINGS OF SOME PORTUGESE WORDS.

C. = Centigrade (temperature).
Fahr. = Fahrenheit.
km. = Kilometer.
m. = Meter.
cm. = Centimeter.
mm. = Millimeter.
kgm. = Kilogram.
gm. = Gram.
cgm. = Centigram.
mgm. = Milligram.
l. = Liter.
c. c. = Cubic Centimeter.
Sq. = Square.
An. = Annual.
Wt. = Winter.
Spr. = Spring.
Sm. = Summer.
Aut. = Autumn.
Gr. = Greenwich.

For the abbreviations used in the Maps *see* Notes on Maps in Appendix III.

Alto = high.
Baixo = low.
Branco = white.
Caes = quay.
Caldas = thermal springs.
Concelho = commune, a certain number of villages and boroughs which have the same municipality.
Foz = mouth of river, estuary.
Jardim = garden.
Leste = east.
Praia = beech.
Praça = square.
Pena, penha = cliff, rock.
Quinta = country house.
Ria = lagoon.
Rial = royal.
S. = before a word commencing in a consonant, *San*, ex. *San* Paulo = St. Paul.
S. = before a word commencing in a vowel, *Santo*, ex. *Santo* Antonio = St. Antony.
Serra. = mountain, hill (*Sierra* in Spanish).

The *nh* and *lh* are liquids in Portuguese, being pronounced like *gn* and *gl* in Italian and French, and *ñ* and *ll* in Spanish.

ERRATA.

The following are the most important:

Page 106, line 18, please substitute *Berghaus* for «Berghans».
» 149, » 9, *temperature* for «temperaiure».
» 224, » 5, *nearly* for «nearq».
» 227, » 22, *jugful* for «jugfull».
» 318, » 35, *Brüt* for «Bürt».
» 320, » 4, *an* for «as».
» 320, » 11, *exuberancy* for «exhuberation».

PART I.

THE CLIMATE OF PORTUGAL

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CHAPTER I.

PRELIMINARY REMARKS ON CLIMATE, METEOROLOGY, AND WEATHER.

In the temperate belt the weather forms one of the most important concerns of the daily life of man.

1. DEFINITION OF CLIMATE, METEOROLOGY, AND WEATHER.

The *climate* of a country may be defined in the words of Hippocrates as the conjoint influence of «the air, land and water upon all organised beings (1).

Charaka, the great Indian medical sage, whose work has not yet received that amount of attention which it deserves, attributes the health of the population of a country to the atmosphere, water, soil and time of the year or seasons; and adds, «when these four become invested with perverse virtues there is destruction of cities, towns and villages» (2).

And Humboldt, the illustrious founder of scientific climatology in its modern aspect, says: «The term climate, taken in its most general sense, indicates all the changes in the atmosphere, which sensibly affect

our organs, as temperature, humidity, variations in the barometrical pressure, the calm state of the air or the action of opposite winds, the amount of electric tension, the purity of the atmosphere or its admixture with more or less noxious gaseous exhalations, and, finally, the degree of ordinary transparency and clearness of the sky, which is not only important with respect to the increased radiation from the earth, the organic development of plants and the ripening of fruits, but also with reference to the influence on the feelings and mental conditions of men» (3).

For the purposes of this book, climate may be defined as the influence exercised upon the public health, and upon the physical, intellectual and moral development of the inhabitants of Portugal by the combined result of the degree of temperature, the amount of humidity, the intensity of winds, and by the other climatic factors, as they are determined by the geographical and topographical feature of the country, and as they are controlled by the prevalent winds. The winds play a double rôle: they act by their intensity, and they act by the influence they have in the distribution and variations of the various factors of climate.

Meteorology differs from climatology in being a wider and, in a sense, purer science. Its aim is the study of all the phenomena which take place in the atmosphere, and to find out their causes and their correlation. It leaves the study of their influence upon organised beings and of their application to arts and sciences, chiefly, to the medical man; to the zoologist and live-stock farmer; to the oceanic and aerial navigator; and to the historian and the philosopher. A meteorologist renders great service to the medical cli-

matologist, but he does not often note, even in first class observatories, many of the facts which are useful to a medical man. The prime motor of all, or almost all, the meteorological phenomena is the sun. The influence of the moon upon climate, compared with that of the sun, is insignificant.

Weather is a term used to indicate the meteorological condition of a country during a short or a long period of one year. A fixed average of successive years constitutes the climate of a country. The weather has the appearance of being variable, but there is more or less a constancy in its irregularity. The condition of the weather in the temperate belt forms one of the most important concerns of the daily life of man.

2. CLIMATE OF PORTUGAL.

The importance of the study of climatology has been recognised from the earliest times. To mention only one author: Hippocrates, in his most admirable treatise on *The Air, Water, and Land,* has pointed out how climate influences the physical and moral development of nations; in his *Aphorisms* and other writings, has shown how the various seasons give rise to different diseases; and in his work on *Epidemics,* has recommended a change to a suitable climate as a cure in chronic diseases.

The climate is much more variable in the temperate belt than in the warm or the cold.

The mildness of the climate of Portugal, the exquisite charm of its blue clear sky, and the beauty of its scenery have been sung, in prose and in verse, by several writers, both national and foreign. One of the

most prominent among them is Macedo, for some time the first secretary to the Portuguese Embassy in Great Britain, and afterwards the Secretary of State to Affonço VI. In a book published in 1631 he says: «The best thing that any country can possess is a good climate, upon which depends not only the good or the bad qualities of the products appertaining to the land itself, such as fruits and other things, but also the character of the inhabitants themselves». And, in describing the Lusitanian climate, he remarks: «Its heavens are very serene and limpid, the climate is very mild, for in winter the cold is not severe, and in summer the heat is not very great, and so, during the whole year, the climate is healthy» (1). Further, this genial writer tries to prove that if the Elysian Fields described by the ancients do exist, they must be situated in Portugal, and if they are situated in Portugal, they must be in the province of Minho! Another writer in his enthusiastic admiration of the Portuguese climate exclaims: «Happy would many countries be if the best spots of their climate were equal to the worst of Portugal»! And, among modern writers, Byron, charmed with the country, sings in his *Childe Harold:*

> «Oh Christ! it is a goodly sight to see
> What Heaven hath done for this delicious land!
> What fruits of fragrance blush on every tree!
> What goodly prospects o'er the hills expand»!

The climate of Portugal in its medical aspect has not yet received much attention. In 1762, Saldanha, who has been styled «a true son of Hippocrates in Portugal», described the influence of the topography of the various provinces upon their climates, and the

influence of the climates upon the health and upon the diseases. He also pointed out, more fully than some of his predecessors, the influence of the four cardinal winds upon the prevalence of certain diseases (2). Among recent writers, Dr. Carvalho, of Guarda, has a valuable paper on the climatic stations of Portugal in the treatment of consumption (3).

The study of the nature of the climate of any large country presents many difficulties. Climates vary at very short distances. A single city like Oporto, where there are two observatories at a distance from one another of one and a half kilometres, the observations made at one station differ very considerably from those made at the other. It may be easily imagined, therefore, what a number of climates there are in a country of the size of Portugal and how impossible it is to describe them all. The only way of obtaining an insight into the climate of a large country is to note the metereological features of as many and as widely distributed typical centres of observation as possible, and then to examine their characteristic geographical and topographical features, and to find out what are the prevalent winds which modify the phenomena of one centre as compared with another, and thus to form, as far as possible, an accurate idea of each region; and then, by comparing one region with another, to form a general and a more or less rational idea of the whole country.

The study of the influence of the climate upon man is attended with still more difficulties, for the climate forms only one of the elements in the development of a race, and in the production or in the cure of disease. But it is only by establishing a correlation between the various factors of climate among themselves, and

between these factors and the human organism that the subject of medical climate can be made interesting and attractive.

One of the drawbacks in the study of climatology is that the terms used to describe a climate do not always convey the same meaning. What one writer terms cold the other terms temperate; what one calls moderately humid, the other calls very humid. This creates a great confusion. An attempt is made in the following pages to give the meanings of such words used in this book.

Another difficulty is the use of terms in the description of seasons. For instance, the same term cannot be used to describe the annual evaporation and the seasonal evaporation. As a basis for seasonal descriptions a uniform plan has been adopted.

3. METEOROLOGY OF PORTUGAL: METEOROLOGICAL STATIONS AND STATISTICS.

Meteorology, like climatology, is a very old science, and owes its origin in Europe also to the Greeks. Aristotle was the first writer, who collected in his treatise on *Meteors* (1) all the prognostics of weather, and described the theory and the origin of winds as understood in his days. His work, on what he styles «a splendid science», although erroneous in many respects, is still full of interest. He was followed by his pupil Theophrastus (2), who went a step further, and explained the phenomena which accompany or follow the winds. These two works formed the main basis of the knowledge of the science till the renaissance, when the air thermometer was invented in 1590, and

the barometer in 1643. The thermometer was modified and improved by Fahrenheit in 1714, and it is from this year that a commencement was made to observe the temperature of the air in various parts of the world.

Meteorology in its philosophical aspect may be said to be due, in a great measure, to Dalton, who established besides many other points of great interest, the theory of winds, and their relation to the barometre, to temperature and to rain (3). But it is to Humboldt that is due the credit of the foundation of the experimental meteorology in its modern aspect; it is he who first established the system of isothermic, isotheric and isochimenic lines (4); it is he who, by his numerous publications, added immensely to the knowledge of the climatic geography of the globe; and it is he who laid the foundation of the scientific distribution of plants based upon climate.

But pure scientific facts, such as those established by Dalton and Humboldt, do not appeal to the general public or to governments, who look to science, as a rule, for material advantages. The necessary stimulus was given by Maury, the founder of the scientific marine meteorology, who by his study of the atmospheric and oceanic currents showed, from 1848 to 1852, how the voyages in sailing ships from New York to Rio de Janeiro could be curtailed by 10 days; to Australia by 20 days; and to California by 30 (5). This gave rise to a great commotion in the commercial world, and eventually led to the International Conference held at Brussels on the 23rd. August, 1853, in which Portugal was represented by J. de Mattos Corrêia, and Great Britain by F. W. Beechey and Henry James (6). The result of this meeting was the establishment of the

Infante D. Louis Observatory in Lisbon in 1854; of the Meteorological Department of the Board of Trade, now known as the Meteorological Office, in England, and of several other observatories in various parts of the world. It may be mentioned here that the study of the principles laid down by Maury, led Brito Capello to show how the voyage from Lisbon to Benguela and to Loanda could be reduced from 60 or 80 days to 30 or 40 (7).

The history of meteorological observations in Portugal may be divided into two periods: one previous to the opening of the official observatory in Lisbon, and the other subsequent to it.

In the first period there are some names, worthy of record. In Lisbon, Pretorius (8) commenced his observations in 1777 and carried them on for about 20 years. He was followed by Franzini (9) who carried the work most enthusiastically on for about 40 years, from 1816 to 1856. And, among others, the Rev. H. Hill, Chaplain to the British Factory in Lisbon, also made some observations from 1783 to 1785 (10). At Oporto Dr. J. B. Lopes made some observations in 1792 (11); and it is said that he was the first physician in Portugal to utilise his knowledge in the treatment of disease. Further, Coimbra had its Professor C. B. de Lacerda Lobo; Mafra its J. A. Velho; Portimão its Dr. J. N. Chaves; and Lobrigos, Montalegre, and several other places their local observers (12); which shows that meteorology had a considerable number of devotees in this country.

In the second or the official period there is one name which stands quite preeminent; it is that of Brito Capello, who, by his numerous contributions (13), has

established for himself, in his speciality, a well-earned reputation not only in Portugal but in the whole of Europe.

There are 15 meteorological *stations* in Portugal, namely: Montalegre, Moncorvo, Oporto, Guarda, Estrela, Coimbra, San Fiel, Campo Maior, Vila Fernando, Cintra, Lisbon, Evora, Beja, Faro, and Lagos. There are 4 more stations the reports of which are not published in the Meteorological Annals of Lisbon: Gerez, Tancos, Vendas Novas and Sagres. The Director of the Meteorological Observatory in Lisbon, Prof. Almeida Lima, opened a temporary post at Mont'Estoril in February 1913. If all the 19 permanent stations be taken into account, there is one station in every 4,688 sq. km. of the country. Besides these there are three stations in the Archipelagos of the Azores and Madeira: Angra do Heroismo, Ponta Delgada, and Funchal.

Compared with 1 meteorological station for every 4,688 sq. km. in Portugal, there is one in 96 sq. km. in the British Isles; 1 in 176 in France; 1 in 627 in Italy; and 1 in about 17,400 in Spain. Some more stations established at Bragança, Braga (Bom Jesus), Viana do Castelo (Sta. Luzia), Bussaco, and Arrábida (Monte Regina) would be useful in giving a more accurate idea of the climate of the country from the medical standpoint. For agricultural purposes the centres of all the districts should have meteorological stations.

The meteorological observations made at some of the stations in Spain, such as Guardia, Salamanca, Madrid and Badajos are of some interest to the student of the climate of Portugal, for they show how the climates of the two countries differ from one another.

For the main purposes of this book 5 typical stations

have been selected for special study, namely, Oporto, Lisbon, Lagos, Moncorvo, and Beja, while all the other stations are referred to as occasion arises. All the *statistics* of the 5 stations, expressly prepared for this book, represent the mean of 10 years, from 1896 to 1905. As the number of years is not very large, it is probable that some of the inferences deduced from these statistics may have to be modified when statistics for a larger number of years are available. In the description of Lisbon as a health resort (Ch. xv. 3) the means of a larger number of years have been given, which differ in some respects from the means of 10 years. The statistics as regards Coimbra, Guarda, Montalegre and Campo Maior are also for 10 years, whereas for the remaining stations they are for the year 1904, which represents the nearest approach to the means of 10 years. Whenever the data of any station are incomplete they have been substituted by the means of the immediately preceding and following observations. All the observations which do not depend upon self-registering instruments have to be taken with some reserve, for in such cases personal equation has to be taken into account. This is specially noticeable, as will be seen further on, as regards the amount of ozone in the air. The characters of the climate of those places where there are no meteorological observations have naturally to be taken with some reserve. In an Appendix the principal climatic factors are given for each month of the year 1904, for all the stations.

It would be an immense advantage to the student of climatology if all the meteorological stations in Europe, or in the world, would adopt a uniform plan in calculating the averages of their observations. The most

useful plan would be to calculate the means of every decennial period, commencing, say, from 1901 and ending in 1910, from 1911 to 1920, and so on. Such averages would be useful not only in comparing any one place with another but also in calculating very easily the means of 20, 30 or more years.

4. THE WEATHER OF PORTUGAL.

The study of weather, of typical storms or of abnormal weather, is of great interest. It has received popular attention from the earliest times. The forecast of weather is of great importance from the medical and from many other points of view. The scientific study of weather is of a quite recent origin. In Portugal, Brito Capello has devoted to it one of his memoirs (1).

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CHAPTER II.

THE CLIMATIC GEOGRAPHY OF PORTUGAL.

Sit medicus cosmographus, qui suae artis solia pedibus converterit, et oculis ipsis perviderit quid uniquique regioni proprium ac peculiare sit.

PARACELSUS: *Opera omnia,* Geneva, 1659, vol. I., pg. 292.

I. GENERAL DESCRIPTION OF PORTUGAL AND OF ITS CLIMATIC REGIONS; THE MAIN ELEMENTS OF CLIMATIC GEOGRAPHY.

The Republic of Portugal, «the Happy Land» of the ancients, and the most westerly portion of Europe, consists, for political purposes, of Portugal and of the Archipelagos of the Azores and Madeira. The continental portion forms an elongated parallelogram, and measures in its greatest length 561 km.; and in its greatest breadth, 218; the total area being 89,106 sq. km. It occupies less than one-sixth of the Iberian Peninsula; less than two-sevenths of the British Isles; and less than one-hundredth part of Europe. It is bounded on the north and the east by the Spanish Provinces of Gallicia, Leon, Estremadura and Andalusia, and on the west and on the south by the Lusitanian Sea; the land frontier has a length of 1,209 km., and the marine, 845.

The land boundary is formed on the north, successively, by the valley of the Minho, and the Sierras of Penegacho, Seca and Peña Negra; on the northern portion of the eastern frontier or above the valley of the Tagus, by the Sierra de la Culebra, by a portion of the Douro, and by the Sierras of Gata; and on the southern portion or below the Tagus, by the courses of the Sever, by the Guadiana and its tributary the Chanca, and by the Guadiana again.

The marine boundary or the coast is generally apeaking moderately high and rugged, interspersed here and there with beautiful sandy shores. The direction of the western coast from Caminha to Cape St. Vincent is gently south-west, intercepted mainly by the promontories of the Capes of Roca and of Espichel, and by the bays of Cascaes and of Setubal. The western coast presents two interesting features: its contour between Caminha and Espinho has a gentle south-easterly direction, which exposes it to the south-westerly winds; whereas the contours from Espinho to Cape Carvoeiro, and from Cape Sines to Cape St. Vincent, have a south-westerly direction, which exposes them to the north-westerly winds. The southern coast runs, as a whole, gently north-eastwards, from Cape St. Vincent to the mouth of the Guadiana. It presents two gentle curves, the first of which runs northwards and the second, southward having more or less the shape of S laid crossways. Where the coast is very low, as at Aveiro, Setubal and Olhão, there is a tendency to the formation of lagoons and marshes. The peninsulas of Roca, Espichel and St. Vincent are, from the climatic point of view, the most important portions of the country along the coast.

Portugal is separated from Spain by natural boundaries. The rivers Minho, Douro, Tagus and Guadiana are not highways or lines of communication with the inland of Spain, but rather strong barriers sunk in deep gorges.

Portugal was divided in olden days into 8 provinces, and at present it is divided for administrative purposes into 17 districts (Map 1), as follows:

1) *Minho* consists of the districts of Viana, Braga and Oporto;

2) *Traz-os-Montes* or Beyond the Mountains, of Vila Rial and Bragança;

3) *Beira-Mar* or Littoral Beira, of Aveiro;

4) *Beira-Alta* or High Beira, of Vizeu and Coimbra;

5) *Beira-Baixa* or Low Beira, of Guarda and Castelo Branco;

6) *Estremadura,* of Leiria, Santarem and Lisboa;

7) *Alemtejo* or Beyond the Tagus, of Portalegre, Evora and Beja; and

8) *Algarve,* of Faro.

The provinces have an interesting history. A large number of them were formed by a natural progress of political evolution, so that each is separated from its neighbour by some distinctive natural boundaries.

For the purposes of this book Portugal with the adjacent islands is divided, upon the basis of prevalent winds (Ch. IV. 5 and Ch. IX. 1-3), into 6 *Climatic Regions* (Map II) namely:

I) The North Atlantic, consisting of the provinces of Minho, Beira Mar, Beira Alta, with the westernmost part of Traz-os-Montes and with the northernmost part of Beira Baixa;

II) The LUSITANIAN, corresponding nearly with Estremadura and Beira Baixa;

III) The MEDITERRANEAN, or the SOUTH ATLANTIC, corresponding nearly with Algarve;

IV) The NORTH CONTINENTAL or the ULTRAMONTANE, with Traz-os-Montes;

V) The SOUTH CONTINENTAL, with Alemtejo; and

VI) THE OCEANIC or the INSULAR, with the Archipelagos of the Azores and Madeira (Map VI).

The exact limits of each of the regions will be described further on, but for practical or statistical purposes the N. Atlantic region may be said to consist of 3 provinces; the Lusitanian, of 2; and the remaining, of 1 each. The insular region has no intimate relations with the other five regions, and will be described apart under a separate chapter.

The *climatic* and the *medical geography* consists of those factors and features of a country which modify the climate, and influence directly or indirectly the health, the vital functions, and the character and nature of diseases of the inhabitants. These factors and features are: Latitude, Altitude, Soil, Water, Vegetation, Habitations, and Atmosphere.

There are several works devoted to the geography of Portugal. Among the most important are those by Balbi (1), Barros Gomes (2), Pery (3), and Dr. Silva Telles (4). The work of Balbi is of great interest from the historical point of view; and that of Barros Gomes marks a distinct epoch in the scientific study of the subject in Portugal.

2. LATITUDE AND SEASONS.

Portugal lies between 36° 58′3″ and 42° 9′0″ N. *latitude,* and between 6° 15′ and 9° 30′ W. long. Grw. The only portion of the Continent which lies below the lowest latitude of Portugal consists of that portion of Spain to the south of the Sierra of Algodomalles in Andalusia, and of the Sierra Nevada in Granada; and of that portion of Greece situated to the south of Sparta. Lisbon stands in about the same latitude as Badajos and Palermo; and Oporto in the same as Salamanca, Barcelona and Naples. The distance between the highest parallel of latitude of Portugal and the lowest of the British Isles is 7° 48′.

Other conditions being similar, the climate of a country varies more according to the extent of its latitude than its longitude. Portugal being about three times as long as broad presents greater varieties of climates than many other countries of its size, the length of which is proportionately less than the breadth.

If the world were homogeneous, and if it were a regular and plain ellipsoid, the natural climate of a country would correspond exactly with the solar or the astronomical, and each parallel of latitude would represent, year after year, the same climate. But such is not the case. Owing to the irregular distribution of land and water, to the mountains and valleys, to the diversity of soils, and the amount of vegetation, the climate of one country differs very considerably from that of another country in the same latitude. The study of the physical geography is, therefore, one of the most

essential conditions to understand well the natural or the physical climate.

The *seasons* form one of the most important cosmic features of climate. Medically considered, the mean seasonal characters of a climate are of much more importance than the mean annual. The climates are described as they occur mainly in winter and in summer, the intermediate seasons partaking partly the characters of one or the other as the case may be. Each medical season consists of three calendar months: winter, spring, summer, and autumn commence on the 1st of December, March, June and September, respectively. Astronomically considered, all the four seasons are well-developed or best balanced in the latitude of 45° degrees; but, actually and practically, the seasonal characters of a country are dependent upon its geographical and topographical features.

3. ALTITUDE AND CONFIGURATION OF THE FIVE CLIMATIC REGIONS; CITIES AND TOWNS WITH AN ALTITUDE OF UPWARDS OF 500 METRES.

The most important features of mountains, as regards climate, are their elevation, direction, and configuration. The mountains have a double influence upon climate: one due to mere height, which renders the climate on their tops similar to the countries of a higher latitude; and the other due to their direction and configuration, which makes them act as recipientes of, or barriers against, the favourable or unfavourable winds. Given the same latitude, there is a greater variety of climates in a country which has

several mountains than in one which consists merely of plains.

The valleys act as channels to the winds to which they are exposed. Their influence depends not only upon their direction but also upon their elevation, and their width, for a narrow and a high valley has a different climate from that of a broad and a shallow one.

Although a plateau may have the same elevation as a mountain, still the influences of the two are quite different. A plateau does not act as a barrier against winds, whereas even a small hill is very important in this respect.

A very low plain has a tendency to be marshy.

If a rough line be drawn from the estuary of the Minho to the estuary of the Guadiana, it will be found that the western triangle consists chiefly of plains with spurs of mountains running from east to west; whereas the eastern triangle is composed mostly of plateaus and of high mountains. The subalpine altitudes are limited entirely to the regions to the north of the Tagus; whereas three-fourths of the regions to its south consist of plains. The mean altitude of the northern regions is about 400 m., and of the southern 250, as compared with the mean altitude of 700 m. of Spain.

The low plains, lowlands or those not exceeding 50 m. above the level of the sea, form 11.79 per cent. of the whole country; the high plains or uplands, 50–400 m., form 59.67 p. c.; the low altitudes or highlands, 400–700 m. form 17.01 p. c.; the moderate altitudes, or the mountain climatic zone, 700–1200 m., form 11.02 p. c.; and the high or subalpine, and the very high or alpine zone, above 1200 m., form 0.51 p. c.

The high plains form more than one-half of the country; and the low plains and the moderate altitudes are about equal.

In Portugal an altitude of over 1.200 m. may be considered to be, as regards vegetation, as alpine, or the zone in which trees cease to grow.

The only elevation in the Republic of Portugal with a perpetual snowline is Pico or the Peak, in the Archipelago of the Azores.

The study of the mountains of a country is of great climatic importance, for they form the best lines of demarcation between different regions and subregions.

I) The N. Atlantic Region. This region is separated from the N. Continental by the crest of the Serra of Marão on the east, and by that of Montemuro on the north; and from the Lusitanian by the crest of the range of the Serra of Estrela.

The principal chains or groups of chains in this region, named after the principal peaks, are:

1) *Gerez*, or the group lying to the north of the Tamega, comprising the Serra of Peneda 1,415 m. and extending down to Sta. Luzia in Viana do Castelo 553; Larouco 1,361, Amarela 1,361, Gerez 1561, and Oural 723, lying between the Cavado and the Lima; and Alturas 1,279, and Cabreira 1,276, extending to Luzim 559, towards the coast, and to the Serra do Pilar 100 m., in Oporto, towards the south-west. All these serras could be separated into minor groups. Their general direction is N. E. to S. W.;

2) *Marão* or the chain situated between the Tamega and the Tua, consists of Padrela 1,147, Alvão 1,310, which runs from N. E. to S. W.; and the crest of Marão 1,415, the direction of which is due N. to S.;

3) *Montemuro* or the Mountain Wall, lies between the valleys of the Douro and of the Vouga, and consists of Marofa 974, Sirigo 987, Leomil 1,012, and the peak of Montemuro 1,382. Its general direction is E. to W.;

4) *Caramulo,* or the serras between the Vouga and the Mondego, consisting of Talhadas, Alfosqueira, the peak of Caramulo 1,070, Bussaco 549, running down to Buarcos 215, and Cape Mondego 77, to the north of the Figueira da Foz. Their general direction is from N. to S. and from E. to W.; and

5) *Estrela,* lying between the Mondego and the Zezere, and consisting of Guarda 1,039, Estrela or Cantaro Delgado 1,991, Açor 1,340, Lousã 1,202, Sica 551, extending through the hills of Albergaria to Lavos, to the south of Figueira da Foz. General direction first from N. E. to S. W., and then from E. to W.

The valleys in the province of Minho are narrow and precipitous; they follow the direction of the serras by which they are formed. Those of the rivers Minho, Lima, Cavado, and Ave, and of the Tamega, an affluent of the Douro, run from N. E. to S. W. The valley of the Douro, after joining its affluent the Agueda, runs across the whole breadth of the country from E. to W. All the valleys of the affluent of the Douro in Beira Alta and Beira Mar, such as those of the Agueda, Côa, Tavora and Paiva, have a direction from S. to N. The Vouga has a course from E. to W. And the beautiful valley of the Mondego, watered «by the tears of the charming D. Ignez» runs from N. E. to S. W. down to Coimbra, and then from E. to W. down to the sea.

If a line be drawn from Caminha to Coimbra al-

most all the land lying to the west will be found to be composed of plains below 200 m. in height, much of it, especially in the districts of Aveiro and Coimbra, being below 50 m. The most important plateau in the North Atlantic region is that of Vizeu, which has a mean elevation of 450 m.

II) THE LUSITANIAN REGION is separated from the N. Atlantic by the crest of the chain of Estrela, which ends on the coast at Lavos; and from the S. Continental mainly by the chain of the serra of Ossa. This region includes those portions of the districts of Lisbon, Beja and Algarve lying to the west of a line drawn from Palmela through Atalaia, Cercal and Espinhaço do Cão down to Cape St. Vincent.

The principal serras in this region are: (1) *Gardunha,* lying between the Zezere and the Tagus; it consists of the Mezas 1,200 m., Maravana, Gardunha 1,223, and Alvelos, all extending from N. E. to S. W. (2) *San Mamede*, 1,027 m., to the south of the Tagus, in Portalegre, and to the Ribeira Grande, an affluent of the Sorraia. (3) *Monte Junto* or the chain lying between the valley of the Tagus, after the confluence of the Zezere, and the coast, comprising Aire 673 m., Candieiros 485, Monte Junto 664, down to Monsanto 226, in Lisbon. Its direction is N. E. to S. W. (4) *Cintra*, lying between the rivulet of Colares and the Bay of Cascaes, consisting of the peak of Cruz Alta 529 m., Monge 496, Peninha 493, extending to Cape Roca 149. Direction E. to W. And (5) *Arrabida* situated between the Bay of Cascaes and the estuary of the Tagus on the north, and the Bay of Setubal and the estuary of the Sado in the south. Its principal peaks are Palmela 393 m., Formozinhos 499, and Risco

380. It runs from E. to W. and ends in Cape Espichel, 135 m.

The valley of the Zezere has a direction from N. E. to S. W. The broad and pleasant valley of the Tagus runs from E. to W. down to its confluence of the Zezere, and then from N. E. to S. W.

The portion of the country lying to the east of Monte Junto down to the basin of the Tagus, and that lying to the north-west and west, down to the coast, consists of plains below 200 m. high, a considerable portion near the coast and near the river being below 50 m. The country bordering on the left bank of the Tagus and a large portion of the basin of the Sorraia are below 50 m. In the district of Portalegre there is a plateau with a mean elevation of 450 m. A considerable portion of the ground to the west and the south of the Bay of Setubal consists of plains below 50 m.

The valleys of the Vouga and of the Mondego in the N. Atlantic region, and the valley of the Zezere in the Lusitanian region run towards Guarda, so as to expose this district to three distinct influences.

III) The MEDITERRANEAN REGION lies to the south of the crest of the mountains of Algarve. The principal elevations of the serras of Algarve are Monte Figo 411 m., Almirante and Foia 903, running into Espinhaço do Cão 253, and ending in Cape St. Vincent, 56 m.

All the valleys in Algarve, such as those of Monchique and Portimão run from N. to S.

The country near the coast is low, below 50 m.; that intervening between this zone and the mountains has a mean elevation of 200 m.

IV) THE N. CONTINENTAL REGION is separated from

the N. Atlantic on the west by the crest of the chain of Marão, and on the south by that of Montemuro.

This regions is dotted with the elevations of Montezinho or the Small Mountain 1158 m., Crôa 1270, Nogueira 1416, Luz 911, Bornes 1202, and Mogadouro 1008. The elevations represent the heights above the level of the sea, but the actual heights in relation to the plateau in which they are situated are below one-half. This is the reason why one of the principal peaks is termed the «Small Mountain».

The portion of the valley of the Douro in this region and the valleys of the Sabor and the Tua, the general elevation of which is between 200 to 500 m., run from N. E. to S. W.

Nearly the whole of this region consists of a plateau with a mean elevation of 700 to 800 m.

V) THE S. CONTINENTAL REGION consists almost entirely of a large portion of Alemtejo, and comprises all the portions not included in the Lusitanian and the Mediterranean regions.

The principal mountains are those of Ossa 650 m., Monfurado 400, which separate the basin of the Sorraia from that of the Guadiana towards the east, and from that of the Sado towards the west. Their direction is from E. to W. Atalaia 325 m. and Cercal 344 m., form a range of hills running along the coast from N. to S., from the Grandola to the Mira.

The valley of the Sado runs from S. to N. down to Alcacer do Sal, and then from S. E. to N. W; that of the Mira also runs from S. E. to N. W. The valley of the Guadiana has a direction from S. to N., whereas all its small affluents rising in the serras of Algarve run from E. to W.

This region has not a distinct line of demarcation separating it from the basin of the Sorraia. It consists of plains and low plains. The country bordering on the Sado and the Guadiana is below 50 m. in elevation. A large portion of the region to the east of the basin of the Sado, and to the north of the mountains of Algarve has as elevation between 200 to 300 m., whereas all the remaining portion is between 50 to 200 m. The famous plains of Ourique have an elevation of a little over 200 m. This region may be compared to a flattened saddle, the front being formed by the mountains of Algarve, the rear by those of Ossa, and the ridge by the plateaus of Ourique, Castro Verde, Beja and Cuba; by the Serra of Portel; and by the plateau of Evora, which all separate the sides of the saddle or the declivities towards the sea on the west, and towards the Guadiana on the east.

The *highest peak* in the five regions of Portugal, the Cantaro Delgado of the Serra of Estrela, attains an elevation of 1991 m. There is no mountain in these regions with a perpetual snow-line. In the Pyrenees, lat. 42° 43′, the limit of the perpetual snow line is 2727 m; and in the Sierra Nevada, lat. 37° 10′, the perpetual snow-line is at 3410 m. Considering that the Serra of Estrela is about midway between the latitudes of the Pyrenees and of the Sierra Nevada, a perpetual snowline in the Portuguese serra would require an elevation of about 2400 m. The highest peak in Spain is Mulaihacen, in the Sierra Nevada, 3554 m; and the highest in the British Isles are Ben Nevis, 1343 m., in Scotland; Snowden, 1094 m., in England; and Corntual, 1037 m., in Ireland. Both in Portugal and in Great Britain, the mountains are found in the

north, the country in the south being more or less flat.

The highest agglomeration of houses occurs at an elevation of 1.130 m; and the highest elevation attained by the pine forests is 700 m.

The *configuration* of the five climatic regions may be summed up as follows.

The N. Atlantic has a general acclivity from S. W. to N. E.; the ascent commencing very near the coast in Minho, and not far from it below the Douro. This configuration exposes it to the S. W. and the W. winds. In Minho the acclivity is intercepted mainly by the chain of Marão, whereas in Beira Alta it proceeds gently right up to the frontier.

The Lusitanian region has also an acclivity from S. W. to N. E. or to the E., but in this case the ascent commences at about the centre of the region, and from the northern border of the Tagus, and of the Ribeira Grande, thus exposing the whole region, but especially the elevations, to the S. W., and also a large portion to the W., winds. Near the coast the serras of Cintra and of Arrabida, which run from W. to E. act as barriers to the N. or the S. winds as the case may be.

The Mediterranean region has an acclivity from S. to N., commencing not far from the sea, which exposes it to the S. winds and shelters it from the N. winds.

The N. Continental has the shape of a saucer, with a gentle slope from N. E. to S. W. The Serra of Montemuro shuts it in from the S. W winds.

The S. Continental being low allows the S. W. wind to blow over it; the acclivity from the basin of

the Guadiana exposes it to the E. winds; and that from the coast exposes it to winds and sea breezes from the W., the free perflation in this latter case being intercepted by the serra of Cercal.

Among the *cities and towns with an elevation of more than 500 m.* are: Guarda 1039, Montalegre 966, Trancoso 891, Monsanto 758, Meda 736, Bragança 684, Pinhal 650, San João da Pesqueira 637, Alijó 601, Penamacôr 574, Vila Flôr 563, Vizeu 540, and Oleiros 517 (Map 1). The figures represent the steeple of a church or some such similar landmark.

4. Soil: composition, permeability, colour, and emanations.

The characters of the soil have comparatively speaking, a very limited influence upon the climate of a country. Those of some importance are: its composition, permeability, colour, and emanations.

The surface of Portugal is *composed* of rocks or soils of various kinds. If a line be drawn from the estuary of the Minho to the estuary of the Guadiana, the eastern triangle will be found to be composed almost entirely of primary formations, and the western triangle mainly of secondary and tertiary formations, with a large patch of the primary below the latitude of 38°. It has been calculated that 7/10th of the territory is composed of the primary or the paleozoic, 1/10th of the secondary or the mesozoic, and 2/10th of the tertiary and quarternary or cenozoic.

Geologically considered, the high Portuguese mountains and plateaus belong to what is termed the Mezeta of the Iberian Peninsula, which has a triangular form,

with its base to a large extent in Portugal and its summit towards the Cape Nao, in Valencia. The base of the tringle presents in its general aspect a gradual descent towards the south-west, thus exposing its surface to the influence of the sea-winds.

The primary formations consist chiefly of granite, schist and the inferior carbonic system: the first is limited mainly to the high mountains in the Beiras, the second to Traz-os-Montes and to the Alemtejo, and the third to nearly the whole of the territory below the latitude of 38°. The secondary formations, consisting of the infralias, the jurassic and the cretaceous systems, are limited to the high elevations in the littoral Beira, and to the northern Extremadura. And the tertiary and quarternary formations occupy the low pains along the littoral and those bordering on the Tagus and the Sado.

In general terms it may be said that the N. Atlantic region consists of granite and schist, a considerable portion of Coimbra being secondary and tertiary, and a considerable portion of Aveiro being tertiary. In the Lusitanian region, Leiria, Lisbon and Santarem consist of the secondary and tertiary; Castelo Branco consists of schist and granite; and Portalegre of schist in the highlands and tertiary in the lowlands. In the Mediterranean region the principal soil consists of schist, the tertiary lying along the coast. The N. Continental is composed of schist and granite, and the S. Continental of schist and tertiary. The nature of the soil determines the amount and the quality of the dust in the air.

As a rule, the soils formed by the primary formations are much more *permeable* than the tertiary or the

quarternary, whereas the secondary occupy an intermediate place. A great deal depends, however, upon the inclination and position of the various strata. The permeability of the soil determines the height of the subsoil water; and the quality of the subsoil determines the composition of the drinking and of the mineral waters.

The *colour* of the soil and the polish of the rocks influence to a certain extent the radiation of heat and of light. The colour of the soil of the zone bordering on the sea is lighter than that of the mountains situated inland. One of the largest patches with a white soil lies between the estuary of the Mondego and the Ria of Aveiro. The mountains bordering on the valley of the Douro have generally speaking a darker tint than that of the other mountains.

A soil may give rise to *emanations* of volcanic origin, or of radio-active substances.

A good general view of the geology of the country may be obtained from the large geological map by Delgado and Choffat (1). The latter has also written the best summary of the geology of Portugal as a whole (2). Among English writers Sharpe may be quoted (3).

5. Water: the Lusitanian Sea, the Gulf Stream, Rivers, Lakes, and Marshes.

The climate of Portugal is immensely influenced by the Sea, and by the Gulf Stream; to a certain extent by its large rivers; and hardly or not at all by its insignificant lakes. There are marshy lands in two or three districts.

The *Lusitanian Sea*, or that portion of the Atlantic Ocean which lies between the west coast of Portugal and a line drawn through the Azores to Madeira, is subject, like all other oceans, to three general currents or movements: the vertical, the horizontal, and the tides and waves. The vertical movement renders the temperature of the surface of the ocean, as far as possible, uniform. There are two horizontal currents: the superficial which proceeds from the equator towards the poles; and the other deep, which travels in the contrary direction. Besides these there is, at a depth of 1000 m. along the coast, a countercurrent from the Mediterranean Sea, the temperature of which, according to Woeikof, is over 10° C. (1). Portugal is the first country in Europe to be influenced by the Atlantic Ocean and the equatorial current. The rise and the fall of tide, and the height and the movement of the waves, influence to some extent the climate on the coast. The mean rise of the tide at Cascaes, off Lisbon, is 1^m61, the spring tide rises to 3^m62, and the neap tide falls to 0^m83. In the northernmost portion of the coast the maximum rises to 3^m70, and the minimum falls to 0^m80; and in the southernmost portion the respective numbers are 3^m40 and 0^m80. The flood tide comes from the north-west along the western coast, and from the south-west along the southern: the ebb tide takes the south-westerly direction.

The Lusitanian branch of the *Gulf Stream,* (Maps III and IV), or that portion which runs along the coast of Portugal forms a very important factor of the Portuguese climate. Its influence is such that while the annual mean temperature of Lisbon is 15°6, that of Virginia in the United States, situated in the same

latitude, is only 13°3. The direction and the velocity of the current depend upon the direction and the velocity of the winds. In summer the Lusitanian branch sweeps the whole coast from north to south; in winter the same flows southward from the lat. of 40°, and influences the Lusitanian region, whereas the N. Atlantic region is under the influence of the Bay of Biscay branch, or that branch which bathes the southern coast of Ireland. The mean velocity of the whole Gulf Stream has been calculated at 7 km. in 24 hours, and that of the Lusitanian branch at 8.5 km. A strong change in the direction of wind gives rise sometimes to an inverted current. Taken as a whole, the Lusitanian Sea has more currents than any other sea in Europe; which explains the quantity and the variety of fishes to be found in it.

Compared with the Lusitanian Sea, the Mediterranean Sea has no superficial equatorial current; no Gulf Stream, except a small branch which enters the Straits of Gibraltar; and no tides to speak of; but its navigation is more risky.

The principal *rivers* are: Minho, Lima, Cavado, Ave, Douro, Vouga, Mondego, Tagus, Sado, Mira and Guadiana. The largest, or the most important river taking its origin in Portugal is the Mondego, or «the River of the Muses». The superficial area occupied by the beds of rivers and rivulets is 913 sq. km. or nearly 1/200th part of the total surface. The surface of water exposed to evaporation in summer is probably about 300 sq. km. The most noticeable features of all the rivers is the large expanse of the Tagus, known as the Mar de Palha or «The Grass Sea», 12 km. broad, just above the Caes do Sodré. The estuary of the Tagus is 30

km. long, and 11 broad; and the Foz is 7 km. long, 3 broad, and about 30 deep. The spring tide is felt up to a little beyond Santarem. The Vouga and the Sado form large lagoons near their mouths, those of the former have been compared to those of Venice, so that Aveiro is sometimes termed the Venice of Portugal. With the exception of a large portion of the S. Continental region, and of some portions of the N. Continental, the whole country is well-watered by its rivers, the district of Minho being exceptionally favoured in this respect.

A cursory examination of the map of rivers shows that the boundaries of their basins correspond nearly with boundaries of the climatic regions and subregions.

With the exception of the Guadiana all the rivers flow westwards. In Spain the principal rivers flow southwards; and in England eastwards. All these show the respective declivities of the three countries.

The *lakes* are small and uninteresting; they are Farinhões, Escura, Carvoeiro, Obidos, Albufeira and Paraiso. Their influence upon the climate is insignificant.

Along the coast the rocks act as strong barriers against the penetration of the sea-water inland, but where the coast is low and sandy, as at Aveiro and Setubal, there is a tendency to the formation of lagoons and *marshes*. The overflowing of the Tagus in the central Estremadura gives rise to marshes. There are also some patches of marshy land on the southern coast. (Cf. Ch. XI. 3). From the sanitary point of view, a uniformly high-ground water is far preferable to one that is fluctuating. The water absorbing power of soils varies very considerably: turf absorbs twice its

own weight, whereas sand absorbs only one-third of its weight.

6. VEGETATION.

The vegetation may be considered as a factor of landscape, as a modifier of climate, and as an index to the nature (Ch. VIII) of a climate.

Portugal, «the garden planted on the western coast of Europe», presents some charming sceneries. In the whole of Europe, says the French geographer St. Martin, «no portions of any country are more favoured by nature for the charm of their situation and for their marvellous coolness and fertility, than the basin of the Douro, the borders of the river Tamega, and the pleasant borders of the Tagus» (1). Sr. A. Arroyo has described minutely the scenery of each province (2).

The vegetation of a region has no influence upon the general cosmic forces of nature, but it modifies considerably the local climates. The greater its amount, the greater is its influence. In civilised and well populated countries it is not easy to meet with large tracts of spontaneous vegetation, for man removes what is not useful and substitutes, or sometimes forgets to substitute, what is useful. Out of the total area of 89,106 sq. km. the cultivated portion of Portugal amounts to 50,684, out of which about 8 p. c. are forests; 16 p. c. are occupied by planted trees; 7 by vines; 6 by leguminous plants, potatoes, and garden produce; 23 by cereals; and 40 by prairies and pastures. The planted trees with forests form about 1/4 th of the cultivated area. The forests belonging to the State cover an area of 191 sq. km., and consist chiefly of pines.

The most important trees from the sanitary point of

view are the pines, which occupy an area of about 4,000 sq. km. The pine woods extend chiefly from S. Martinho do Porto to Figueira da Foz, and thence to Pampilhosa, and from Pampilhosa northwards to Valença. Some plantations are to be seen in Lisbon, Santarem and some other districts. The pine forest of Leiria occupies an area of 140 sq. km.; it was commenced by Sancho I. and developed by D. Deniz in the XIV century. The forest of Camaride, beyond Moledo, is also due to D. Deniz. It is a great loss that many other parts of the country have not been planted in the same way. The cistuses, which emit an agreeable fragrance on a hot day, are widely distributed. There are important plantations of the Australian gum-trees in some of the regions.

The intensity of vegetation depends upon the amount and distribution of the rainfall (Map V) and upon the richness of the soil. The vegetation is luxuriant in the N. Atlantic region, especially in Minho; it is abundant in the Lusitanian and the Mediterranean regions; and it is sparse in the N. and the S. Continental regions.

The vegetation in the provinces of Spain bordering on the western frontier is sparse and much less varied.

7. HABITATIONS.

A large accumulation of houses, as in large cities and towns, has some influence in modifying the climate of the place. The climate may be all that is desirable. but the disposition of a particular street, or the exposure of a particular house, may be faulty. In all countries in southern Europe there is a general tendency to sacrifice comfort to external appearances.

Instinct and experience have led the people to establish most of the cities towns and villages on the right banks of rivers along the coast, and on acclivities with a southern aspect, in the interior. A fact well worthy of note is that both Evora and Beja are situated nearly on the «ridge» of the S. Continental region.

The number of houses in each town may be judged more or less by the number of inhabitants. Lisbon has a population of 435,360 or 4,964 per sq. km., and Oporto 194,010 or 5.013 per sq. km. There are 7 cities with a population of upwards of 15,000 inhabitants: Setubal 30,360, Braga 24,650, Coimbra 20,580, Loulé 19,690, Evora 17,910, Covilhã 15,750, and Vila Nova de Gaia, 16,500. The number of places with a popula- between 1500 and 5000 is abont 90.

8. ATMOSPHERE.

If the organised life be excluded, the earth consists of three «spheres»: the lithosphere or land, the hydrosphere or water, and the atmosphere or the air. The atmosphere forms an invisible ocean around the earth. Its composition forms such an important element in the climate of a place that it deserves a chapter to itself (Ch. III).

9. CLASSIFICATION OF CLIMATES BASED UPON GEOGRAPHICAL FEATURES; THE NUMBER OF METEOROLOGICAL STATIONS IN EACH CLIMATIC REGION.

Taking *latitude* as the basis, each hemisphere is divided into 5 belts: torrid, tropical, temperate, cold and polar. The temperate lies between 35° and 55°, and is

divided into 2 subbelts, the warm temperate between 35° to 45°, and the cold temperate between 55° to 45°. According to this division Portugal, which lies between 37° and 42°, belongs to the warm temperate subbelt. This is no doubt true from the astronomical point of view, but as a matter of fact, it will be seen further on, only 3/5ths of the country lie in the warm temperate subbelt, and the remaining 2/5ths in the cold temperate.

Dr. Supan divides each hemisphere into 5 Climatic Provinces, and places the whole of Portugal in his Mediterranean Province (1). It will be seen in the course of the following chapters that it would have been more accurate to place the N. Atlantic and the N. Continental regions of Portugal in his West European Province, or to draw a line of division of the Mediterranean and the West European Provinces, so far as Portugal is concerned, through the crest of the Serra of Estrela instead of drawing it, as Supan has done, through the valley of the Minho.

As regards *altitudes*, climates are divided into those of mountains and of plains. Climates of low altitudes have an elevation of 400 to 700 m.; of moderate altitude from 700 to 1200 m.; and of high altitude from 1200 to 1800 m.; and of very high altitudes from 1800 to 2000 m. In Portugal a station of high altitude requires an elevation of 1400 to 1800 m.

The only characteristic climate with reference to *soil* is the volcanic. The soil influences the humidity, the temperature and the amount of light. Hereafter some regions may have to be classified according to the amount of the emanations of radioactive substances.

With reference to the relative position of land and

water, climates are said to be oceanic, insular, marine and continental.

As regards *vegetation,* climates may be described as those of forest or of desert, with several gradations between the two.

And as regards *habitations,* a climate may be urban, suburban or rural.

A detailed description of all these climates will be given further on (Ch. IX).

Based upon configuration, climate, vegetation and population, Prof. Herbertson divides the world into 6 major geographical regions, each consisting of from 1 to 5 types (2). He places the whole of Portugal in his 3rd region: the warm temperate, or the western margin of Europe, with winter rains (Mediterranean type). This is also, like Supan's classification, not quite accurate. Portugal belongs partly to the warm temperate and partly to the cold temperate types.

A table on the next page shows the latitude, longitude, altitude, and the approximate distance from the sea of the 15 meteorological stations (Map II) grouped in order of their latitude from north to south in each climatic region.

As regards latitude, Montalegre stands the highest and Faro the lowest; as regards altitude, Estrela is first or the highest, and Lagos is last or the lowest; and with reference to the sea, Lagos stands the nearest and Moncorvo the furthest. Guarda may be said to belong to the 2nd as well as the 1st region. Of the 4 stations not included in the list, Gerez stands in the 1st, Tancos and Vendas Novas in the 2nd, and Sagres in the 3rd, regions.

Oporto, Lisbon and Lagos, which are about equidis-

tant, represent the climate near the sea of the N. Atlantic, Lusitanian and Mediterranean regions; and Moncorvo and Beja of the N. and the S. Continental regions, respectively. It has to be stated, however, that Moncorvo, which is situated in a hollow, does not represent accurately the climate of the N. Continental region, but there is no other station in that region.

TABLE

	Lat.	Long. W. Grw.	Alt. m.	Dist. from the sea km.
I) N. Atlantic				
Montalegre....	41°.49′	7°.45	1,027	90.0
Oporto.............	41°.9′	8°.34	100	5.0
Coimbra...........	40°.12′	8°.25	140	38.5
II) Lusitanian				
Guarda.............	40°.32′	7°.14	1,039	120.0
Estrela.............	40°.25′	7°.33	1,386	102.0
San Fiel......	40°.22′	7°.31	516	125.0
Cintra..............	38°.47′	9°.50	205	10.0
Lisbon............	38°.43′	9°.9	95	12.0
III) Mediterranean				
Lagos............ .	37°.6′	8°.38′	13	00.6
Faro..............	36°.57′	7°.54′	14	0.5
IV) N. Continental				
Moncorvo..	41°.10′	7°.1′	415	170.0
V) S. Continental				
Campo Maior.......	39°.2′	6°.59′	288	160.0
Vila Fernando.......	38°.58′	7°.13′	375	148.0
Evora............ .	38°.35′	7°.32′	315	120.0
Beja................	38°.1′	7°.55′	284	75.0

Coimbra is the type of a climate away from the littoral; and Campo Maior represents the type of the extreme Portuguese continental climate. Estrela (Poio Negro) represents the best climate of altitude, but it has at present not much practical importance. The climate of Cintra is much under the influence of vegetation or of woods. Guarda and Montalegre are similar to Estrela; Faro resembles Lagos very closely; Evora and Beja are more or less alike; and Vila Fernando resembles Campo Maior. San Fiel may be said to approach Vila Fernando. The post at San Fiel has now been transferred to Castelo Branco.

The latitude, longitude and altitude of the following 4 meteorological stations in Spain are of special interest in the study of the Portuguese climate.

Guardia: lat. 41°.53′; long. W. Madrid, 20°.28′; alt. 8 m.
Salamanca: 40°.58′; 7°.55; and 811 m., respectively.
Madrid: 40°.24′; 0°.0; and 655 m.
Badajoz: 38°.51; 13°.16; and 195 m.

10. DOES PORTUGAL FORM A GEOGRAPHICAL UNIT?

The answer to this question depends upon whether the country is viewed more from the geological or more from the topographical, or climatic, or medical standpoint. From the geological point of view, Portugal is not a geographical unit; but from the topographical or from the general surface relief it is decidedly a distinct unit. Kohl considers the country to be quite distinct from Spain, and styles it the «Netherland of the Iberian Peninsula» (1); and Fischer, who has framed a map showing the configuration of the Iberian Peninsula (2), considers it also the most distinctive portion of all

the regions bordering upon the sea, and compares it likewise with Holland. It would be more accurate to style Portugal the Western Inclined Plane of the Iberian Peninsula, for it is the exposure of the large portion of its surface to the oceanic winds on the western side that gives it its distinctive climate.

11. INFLUENCE OF THE GEOGRAPHICAL FEATURES UPON CLIMATE AND UPON MAN.

The influence of the geographical features of Portugal upon the climate will be described in special sections devoted to the subject in the following six chapters.

A man is a creature of his physical and social environments. The nature and extent of the country; the fastnesses of the mountains; the richness or the poverty of the soil; the proximity and the expanse of the sea; and the forests and general scenery of the country, impress upon him certain psychical and physical traits of character, which, combined with the climate, tend to modify his constitution and character (Ch. x); to give rise, under unfavourable circumstances, to disease (Ch. xi); and, under favourable conditions, to cure them (Ch. xii).

People residing on mountains become, owing to enforced exercices, more hardy. They identify themselves with their grand surroundings, and feel homesick when they are transferred to the plains. A similar but milder influence is exercised upon the people residing on the coast. As a general rule, it may be laid down that a country which presents the greatest variety of physical features impresses upon its inhabitants a greater variety of mental characteristics; and in some way tends to increase the sentiment of personal importance.

The geographical features of a country, combined with the climate, also determine the nature and amount of the vegetable food it is capable of supplying, and the number and quality of the domestic animals it is capable of supporting. And it is upon the nutritive value of food that depends, all other conditions being the same, the strength, the vigour and even some of the diseases of the inhabitants. The Portuguese soil combined with the climate produces some of the best qualities of fruits and of wines.

Between Portugal and Spain there is not only a geographical but also a political and an intellectual barrier. The open door of Portugal is the Atlantic Ocean; that of Spain is the Mediterranean Sea. Gallicia forms a part of the Western Inclined Plane of the Iberian Peninsula.

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10. (1) Kohl (J. G.): *Die geographische Lage der Hauptstäde Europas*. Leipzig, 1874, pg. 112.

(2) Fischer (Theobald): *Reisekizzen aus Spanien und Portugal*, in «Verhandlungen der Gesellschaft fur Erdkunde in Berlin». B. xx. Berlin, 1893, pp. 139-147, Map III.

I have quoted some foreign writers not because their authority is greater than that of the Portuguese, but because they are naturally less biassed when they refer to Portugal.

CHAPTER III.

THE ATMOSPHERE.

The air helps to produce activity of mind and movement of body.

HIPPOCRATES, *On the Sacred Disease.* § 7.

1. IMPORTANCE OF AIR.

The air is the breath of life, *aer pabulum vitae;* it is so essential to life that Dumas has defined all organised beings as nothing but «condensed air».

The earth is surrounded by an ocean of atmosphere which rises to a height of about 211 km., being somewhat lower at the equator than at the poles. It is in the air that all the climatic factors, such as wind, humidity, temperature, and sunshine have their play, and it is through the air that they are conveyed to man.

All other circumstances being equal, the health of man depends upon the purity of air. He consumes 10,000 litres in 24 hours, or more than 400 per hour. The influence of bad air was clearly recognised by Hippocrates, who remarks: «When the air is infected with miasms which are injurious to human nature, men are ill, but when it is injurious to other animals, it is they that suffer» (1). Among modern writers the treatise of Sanches, on the preservaiion of health (2), published

in 1757, in a clear vernacular style, deserves, from the historical point of view, a very high place, for his views as regard the influence of air were far in advance of all his contemporaries.

Some climatologists try to show that the air does not form part of climate in the strict sense of the word. This may be true, but there is no climate without air, and if the air be impure an otherwise good climate is absolutely useless to a patient.

2. COMPOSITION AND PHYSICAL PROPERTIES.

The air is composed of fixed, variable and accidental elements.

The fixed are: 20.7 p. c. by volume of oxygen, 78.3 of nitrogen, and 1 of argon, with traces of some other gases.

The variable are: aqueous vapour, carbonic acid, ozone, ammonia, and nitric acid.

And the accidental are: chloride of sodium, iodides, peroxide of hydrogen, volatile and odoriferous exhalations from certain plants, smoke, oxide of carbon and other gases, organic and inorganic dust of various kinds, and microbes of animal and vegetable origin.

Only the fixed, the variable and some accidental constituents will be described in these pages. The purity of air depends upon the variable and accidental elements. All the constituents of the air may be grouped, in accordance with their usefulness to man, as follows:

Essential: oxygen, aqueous vapour and perhaps nitrogen.

Useful: ozone, peroxide of hydrogen, chloride of sodium, iodides, and volatile and odoriferous exhalations from certain plants.

Indifferent: nitrogen and argon;

Unfavourable: carbonic acid, ammonia, nitric acid, all accidental gases and all non-pathogenic germs when they exceed a certain amount.

And injurious: all poisonous gases, and all pathogenic dusts and germs.

Physical properties. The air is compressible; its volume varies according to *pressure,* and variations in pressure give rise to *winds* (Ch. IV). It always contains a certain amount of *aqueous vapour* (Ch. V). It is liable to variations of *temperature* (Ch. VI). It can be more or less *luminous* (Ch. VII). And it possesses certain other physical characters not yet well-defined.

3. MODIFICATION OF THE COMPOSITION OF AIR DUE TO GEOGRAPHICAL FEATURES AND TO CLIMATIC FACTORS.

1) *Oxygen.*

Provided the pressure be the same there is no difference in the amount of oxygen in different latitudes. Supposing the temperature at the level of the sea to be 0°, a litre of air contains, at an altitude of 5540 m., one-half of oxygen or $0^{gm.}129$ instead of 0,259. Its amount is less on land than on the ocean, and in the open country than in cities, but the differences are insignificant. The air of forests does not contain more oxygen for breathing purposes. Winds blowing from the ocean and those descending from the tops of mountains covered with snow contain a little more oxygen than those blowing from the land, or those ascending from the valleys. Oxygen does not present any variations due to seasons, or to day and night.

2) *Ozone and peroxide of hydrogen.*

The following table shows the mean annual and seasonal amount of ozone at the 5 typical stations.

	An.	Wt.	Spr.	Sm.	Aut.
Oporto...........	3.01	2.89	3.19	2.83	3.29
Lisbon...........	6.19	6.77	6.88	5.38	5.74
Lagos............	6.74	7.94	5.75	7.47	6.66
Moncorvo.........	2.70	3.25	3.33	1.69	2.54
Beja.............	5.9	5.8	7.1	6.3	4.5

The annual means are not of much importance, for the differences depend upon the value attached by each observer to Schönbein's scale. The arseniate of potash test for the quantitative examination of ozone has not yet been adopted at any of the observatories. The seasonal amount is of more importance. It is more in spring than in winter, at Oporto and Lisbon; and more in autumn than in winter at Oporto. The mean annual coefficients of ozone at the other stations, grouped according to the climatic regions, are; (I) Montalegre 7.33 and Coimbra 9.0, (II) Guarda 5.90, Estrela 1.13; and San Fiel, 3.25; (III) Faro 6.50; (V) Evora, 5.99, and Vila Fernando 4.17.

The normal air contains a minute quantity of ozone; at its maximum about 1/10,000 part of its volume. All conditions being equal, there is a greater production of ozone in the lower than in the higher latitudes, but there is likewise greater oxydation. Its amount is more on the ocean than on land; more on high mountains than on plains; and more on the plains than in towns.

It is not certain whether its amount is larger in woodland than in open country, but it is larger in the forests of pines and other resin-yielding trees and shrubs.

Winds blowing on shore and those descending from very high mountains contain more ozone than those blowing from the land or those ascending from the valleys. No country on the Continent receives the equatorial S. W. winds and also the polar N. W. winds in such a pure state as Portugal, for they blow direct without crossing any land. A high degree of humidity is favourable for the production of ozone, and so is intense sunshine.

Owing to the higher temperature in summer than in winter, the amount of ozone from vegetable origin is more in summer than in winter; and it is more in winter when the mean temperature is high, than when it is low. For the same reason it is larger in amount during the day than during the night.

Peroxide of hydrogen is present in very minute quantities, as an accidental element. It is evolved during the evaporation of water caused by heat in presence of sunshine.

Thierry found in 100 c. cm. of air at the Grands Mulets (Mont Blanc) $9^{mgm.}4$ of ozone, whereas on the same day at Chamonix it was 3.5 and at Montsouris (Paris) 1.9 (1). During a period of 20 years the mean annual amount of ozone in Paris, according to Levy, was $1^{mgm.}7$, the extremes being 0.9 and 4.3 (2). And M. Duphil has shown that at Arcachon it is three times more than in Paris (3).

3) *Chloride of sodium and iodides.*

The air contains ordinarily only traces of *common salt*. Its amount on the coast depends entirely upon the

direction, frequency, and the force of winds. It is larger in amount when the winds blow from the sea than when they blow in the reverse direction, rising to as much as $0^{gm.}025$ in a cubic metre in the former case, and falling almost to zero in the latter. It gets less and less in proceeding inland, so that it is not found at all at very high altitudes. Other conditions being the same, its amount on the sea-shore is larger in summer than in winter.

Iodine is present in minute quantities on the sea-coast; its amount depends upon the presence of sea-weeds. It is present more as insoluble compounds of organic origin, than as soluble salts of sodium or potassium. The sea-weeds appear more on the coast of Portugal, as at Figueira da Foz and Mont'Estoril, in August and September, exactly the period of the greatest affluence of people in search of the sea air.

The air of Paris contains 13 times less iodine than the air on the sea-coast.

4) *Volatile and odoriferous exhalations from certain plants.*

The plants whose *exhalations* are considered beneficial are pines, eucalyptuses, various species of cistuses, and of some species of the Labiatae. The amount depends upon heat, moisture, sunshine and winds. The exhalations are, as a rule, more in summer than in winter; but some plants exhale more during the evening and night than during the day.

The distribution of some of the aromatic trees and shrubs which affect the Portuguese air is worthy of notice.

The marine pine *(Pinus Pinaster)* is found chiefly in the regions to the north of the Tagus; and the stone

pine *(P. Pinea),* in the regions to the south. It may be mentioned here that all the specific names of indigenous plants in this book are those adopted by Professor Pereira Coutinho in his *Flora* (4).

The Australian gum tree *(Eucalyptus globulus)* is met with in various regions. There is a large plantation near Abrantes in the Lusitanian region, which is utilised for the extraction of eucalyptol; there is another plantation at Vila Fernando. The myrtle *(Myrtus communis)* is found all over the country.

The genus cistus is scattered widely throughout the country. The gum-cistus (*Cistus ladaniferus,* «esteva» in Port.) abounds everywhere; the poplar-leaved cistus (*C. populifolius,* «estevão») is common in the N. and the S. Continental regions, and in some portions of the N. Atlantic and the Mediterranean; and the laurel-leaved cistus *(C. laurifolius)* in the N. Continental region.

The family Labiatae is represented by several very sweet scented species. The rosemary (*Rosmarinus officinalis,* «alecrim») is common in the south and in the centre. The Stœchas' lavender (*Lavandula Stœchas,* «rosmaninho») is met with chiefly in the S. Continental and the Lusitanian regions; the lavender with long peduncled spikes (*L. pedunculata,* «rosmaninho maior») is largely distributed in the N. Atlantic and the Lusitanian regions; and the true or common lavender (*L. spica,* «alfazema»), the lavender with green bracts (*L. viridis,* «rosmaninho verde») and the multifid-leaved lavender (*L. multifida,* «alfazema de folha recortada») are found in the S. Continental and Mediterranean regions.

The orange and the citron grow almost everywhere.

The melilot (*Melilotus elegans,* «trevo de cheiro»)

and the Indian melilot (*M. indica,* «anaphe menor», «trevo de cheiro») extend from the Douro to Algarve. The broom (*Spartium junceum,* «giesta») is widely diffused.

All these and some other trees and shrubs combine, in due seasons, to render the air delicate, fragrant and balsamic.

5) *Nitrogen* and *argon.*

As these gases are indifferent, their variations have not received much attention. On the whole their proportions are, like those of oxygen, nearly constant.

6) *Carbonic acid, ammonia and nitric acid.*

The *carbonic acid* varies from 0.03 to 0.04 in 100 volumes of air. It is perhaps a little more in the lower than in the higher latitudes: it is somewhat more on land than on the ocean, and on plains than at high altitudes; it is much the same in forests as in the open country; but it is decidedly more in cities and other densely populated places. It hardly varies from season to season, but it is said to be somewhat more during the night than during the day.

The amount of *ammonia* has been estimated at 1 to 5 mgm. in 1 cub. m. of air. It is present wherever there is any decomposition of organic matter; it is greater, therefore, in cities than in the country; and greater in those houses which rear domestic animals, and have manure pits near by. The air emanating from the drains contains it in some cases 5 times more than the ordinary air.

The *nitric acid* varies from 0.3 to 7 mgm. in 100 cub. m.

7) *Smoke and gases of various kinds.*

The gases, occasionally found in the air, are of various kinds. The most common is the smoke resulting from

combustion, which yields formic aldehyde, especially when the pine and the oak are used as a fuel. Besides this the air is often tainted in cities and habitations with sulphuretted and carburetted hydrogen, and with various compounds of chlorine and sulphur. In volcanic regions there may be emanations of sulphureous and other gases.

8) *Dust: organic and inorganic.*

The *dust* consists of fragments of various animal, vegetable, and mineral substances, such as hairs and wool; spores, carbon, grass, paper and wood; and lime, silica, and magnesium. Their number is more on land than on the ocean; more in plains than in altitudes; more from certain soils than others; and much more in cities and manufacturing districts. Their number is sometimes as much as 100 million times more than that of microbes in a given space. The presence of dust in the air is due to winds. If the air were perfectly calm, the dust would soon settle down. Winds may bring in dust from distant parts, and they may help to carry it away. Rain washes the air and purifies it of dust. The amount of dust is much more in summer than in winter.

9) *Micro-organisms.*

These are of animal or of vegetable origin. A great number of them are innocuous. Their number varies from 100 to 1000 in 1 cub. m. of air. Their presence in the air is due mostly to dust. They are much less in the air than on the surface of the ground, and much less over water than over land. They are also much less in the oceanic, mountainous and the desert airs; but exceedingly abundant in cities and in damp localities. It has been found that there is only 1 micro-organism

in 2 cub. m. of air over the Atlantic Ocean to 80,000 in the same space in a hospital. Dr. Pereira has shown that at Oporto their number is lowest with the S. and the S.W., and highest with the N.W. and W. (5). Winds may bring them in or carry them away. A great deal of humidity is favourable to vegetable germs, whereas the extremes of temperature are injurious. Other conditions being equal, a moderately warm temperature is more favourable to their development than a moderately cold. The microbes of animal origin are more common in summer than in winter, whereas those of the vegetable origin are more common in winter than in summer.

4. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS BASED UPON THE COMPOSITION AND PURITY OF AIR.

The prevalent winds and the other climatic factors, combined with the geographical features, determine the class of air of each place.

1) The *oceanic* air, or the air in which all the winds blow from the sea, contains more oxygen and ozone than the land air; it also contains a large amount of marine salts, and is free from all accidental impurities.

2) The *marine* air, or the air of all places where the prevalent winds are from the sea, contains more oxygen and ozone than places far inland; it also contains always some accidental impurities. The saline elements vary according to the distance from the sea. The air of the littoral tract contains iodine. The air of large rivers and large lakes, or the *riparian* and *lacustrine* air, is in some respects similar to the marine. The air of

marshes was considered formerly to be charged with miasms or pathogenic germs.

3) The *continental* air, or the air of places where the prevailing winds are mainly from the land, contains the ordinary amount of oxygen and ozone, accidental impurities such as organic and inorganic dust, and some micro-organisms.

4) The *desert* air, or the air of places where all the prevalent winds are from land, contains a good deal of ozone, but is often charged with a large amount of accidental impurities such as dust.

5) The *mountain* air or the air of altitude contains, volume for volume, less oxygen, but a considerable amount of ozone; very little or no salt; often very little dust and no bacteria. *Low plain* air, when marshy, is liable to contain a large number of micro-organisms, and under certain circumstances, to be infested by anopheles.

6) The *sylvan* air, or the air in woodlands and forests, contains a normal amount of oxygen, and a large quantity of ozone of vegetable origin, especially if the plants are resinous; it also contains a little more of carbonic acid; and is free from pathogenic germs. The *non-sylvan* air is just the opposite of the sylvan. If the land be covered with aromatic shrubs the air may be fragrant or *balsamic*.

7) The *city* air contains less oxygen and ozone, more carbonic acid, more ammonia, more dust, and more micro-organisms than all the other classes of air. The *rural* air contains more oxygen and ozone, and no ammonia or other products due to decomposition.

The mountain, the sylvan and the urban air is further

modified by the greater or lesser prevalence of the sea or the land-winds.

Taking some of the constituents as the basis of classification, the air may be said to be very ozonic, ozonic, or feebly ozonic; very saline, saline, or feebly saline; very odoriferous, odoriferous or inodorous; according to amount of ozone, chloride of sodium, and volatile and odoriferous exhalations from plants. In the same way may be classified the unfavourable and injurious constituents.

Taking the air as a whole, it may be said to be very pure, pure, suspicious, and dangerous. A *very pure* air is that in which one or more of the desirable and useful elements predominate to their utmost degree, as in the marine, mountainous, and sylvan air. The *pure* air is that which contains the normal amount of useful elements, with a minimum of the unfavourable ones, such as the continental, rural and desert airs. The *suspicious* is that which contains a large amount of the unfavourable elements, as in all agglomerations of houses and in manufacturing districts. The *dangerous* is that which contains the injurious elements, and is to be found in cities, especially when the drainage is faulty; and in marshy soils, or soils in which the subsoil water is high.

Due to prevalence of the S. W. winds, to the great number of mountains, and to the luxuriant vegetation, the air in the N. Atlantic region is very marine, very mountainous and very sylvan; it is, therefore, very pure. In the Lusitanian region the prevalent winds being N. and N. W., the mountains receding more from the coast, and the vegetation being less luxuriant, the air is not so marine, so mountainous and so sylvan

as in the former region. The Mediterranean region is exposed to the S. or the marine winds, and is sheltered from the N. or the land winds, and its vegetation is dense; its air is, therefore, marine and sylvan but not mountainous. In the N. Continental region the air is continental and mountainous. And in the S. Continental, it is continental, and therefore the least pure of all.

As Portugal is agricultural rather than industrial or manufacturing, its air is not charged with smoke and other accidental elements as in London, Glasgow, Liverpool and some other cities in the British Isles. There are only two cities with over 100,000 inhabitants. Owing to the insecurity existing in former times there was, and still there is, a considerable amount of agglomeration in rural habitations; but there is a decided tendency among the peasants, at present, to live in their own properties or in detached houses, which is a great gain from the sanitary point of view. When the presence of a very large number and variety of aromatic trees and shrubs is taken into account, it is no mere figure of speech to say that the air of various parts of the country, in certain seasons, is not only very pure but also very sweet and balmy. On the whole, the air of about three-fourths of Portugal is distinctly marine, mountainous and sylvan, and of the remaining fourth it is somewhat continental.

5. EFFECTS AND USES OF THE VARIOUS CONSTITUENTS AND CLASSES OF AIR.

The air is essential to all organic life. Some of the elements as oxygen are essential both to the animal and the vegetable kingdoms; some as ozone, chloride of

sodium, iodides, and volatile and odiferous exhalations are useful to man; some as carbonic acid, nitrogen, ammoniacal salts, nitrates and mineral substances are essential and useful to plants. There is a beautiful and harmonious interdependence between the respiration of the animal and the vegetable kingdoms.

1) *Oxygen.* A man requires 20 l. of oxygen when in repose, and upwards of 25 when working. He may live in an atmosphere containing 15 p. c. of oxygen, but he cannot do so when it falls to 10 p. c. A great decrease of oxygen, as it occurs in very high altitudes, gives rise to what was named by Da Costa, in the xvth. century, mountain sickness, which is characterised by dizziness, palpitation of the heart, nausea, quick and irregular pulse, followed sometimes by unconsciousness due to anaemia of the brain, and even death.

2) *Ozone and peroxide of hydrogen.* The presence of ozone in the air is useful indirectly. It has great oxydising or disinfecting properties, and is destructive of microbes. The direct influence of ozone as it exists in the air is not well understood, it is supposed to act as a tonic and sedative, and to produce sound sleep. Air containing $0^{gm.}05$ per litre is not respirable; it gives rise to irritation of the respiratory organs. The freshness of the air after a thunderstorm may, in part, be attributed to the presence of a larger amount of ozone. It was thought at one time that the intensity of epidemics in a city could be judged by the increase or decrease of ozone, or that when the ozone in the air was greater the intensity of epidemic was correspondingly less. But it is now known that this does not hold good in all cases. Certain epidemics with catarrhal congestions, such as influenza and pneumonia, coincide

with the presence of ozone in the air. It has also been pointed out that ozone, as it exists in some of the seaside places, is not favourable in cases of tuberculosis of the lungs in its evolutionary stage; whereas it is very useful in tuberculosis of the skin or of lymphatic glands.

It is doubtful whether the minute amount of peroxide of hydrogen present in the air is in any way useful.

3) *Chloride of sodium and iodides.* The beneficial action of the marine air is considered by many authors to be due to the presence of the large quantity of chloride of sodium. The compounds of iodine act as disinfectant, and as tonic and alterative especially in children.

4) *Volatile and odoriferous exhalations from plants.* It is generally believed that the exhalation from certain trees and shrubs is beneficial. There is no doubt that they are agreeable, and that their presence is an indication of a large amount of ozone of vegetable origin. The exhalations are considered to be especially useful in lung diseases. Dr. Arbuthnot attributes the beneficial effects of the country air in spring and in summer to the exhalations due to vegetation (1). And Beckford, after remarking how the country around Alcobaça and Batalha was covered in June with lavender and rosemary, and how the sky was of a pale, tender blue, remarks: «To breathe the soft air of such a climate is in itself no trifling luxury; it seemed to inspire new life into every vein: and if to those gifts of Nature the blessings of a free government and the refinements of art were added, more philosophy than I am master of would be required, not to murmur at the shortness of our existence» (2). In pine forests the air is pure and dry; and the soil containing the humus of pine

is not favourable to the development of pathogenic germs.

5) *Nitrogen and argon.* The action of these elements on the human system is not yet well understood. Nitrogen acts as a diluent of oxygen.

6) *Carbonic acid, ammonia and nitric acid.* A man respires 15 to 20 l. of carbonic acid in 24 hours. Life is possible when its proportion in the air is 1 p. c.; when it rises to 3 p. c., it is ver yinjurious; and when it attains 5 p. c., it gives rise to asphyxia. Some persons are very susceptible to its influence. Ammonia and nitric acid are injurious if present in a large quantity.

7) *Smoke and all other gases.* When these exceed a certain amount they are injurious. It is probable that some of the gases resulting from the combustion of fuel, especially of pines, have a desinfectant action. The emanations due to volcanic origin were supposed to be useful in lung diseases.

8) *Dust: organic and inorganic.* Tyndall was one of the earliest writers to call attention to the importance of dust in the atmosphere (3). Some of the organic dusts give rise to diseases as hay fever and anthrax; whereas the inorganic act mostly in a mechanical way, as in disease of lungs in miners and stone-masons. There are about 20 professions in which the dust resulting from various factories is injurious.

9) *Micro-organisms.* The initiation of the study of microbes in the air is due mainly to Pasteur (4). The great majority of germs are innocuous; only a few are pathogenic. Among the principal diseases caused by micro-organisms, in which the air act as a carrier, are tuberculosis, diphtheria, broncho-pneumonia, influenza,

hooping-cough, and measles. The movement of the anopheles which give rise to malaria depends in some measure upon the direction of the winds.

Many of the diseases which were, not long ago, attributed to climate, are now known to be due to microbes in the air, water, food or soil. But all the same, the climate is the main element which determines the presence and the growth of the germs, and influences the course of the disease in man. To mention only one instance: many patients who are subject to malarious fevers get an attack of the disease when there is a sudden change of weather.

The effects and uses of the marine, continental and other classes of air, combined with those of the geographical features and of climatic factors, will be described under Chs. X., XI., and XII.

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CHAPTER IV.

PRESSURE AND WINDS.

> *Whoever wishes to investigate properly the art of medicine must do this . . . the cold and the east winds must be noted, especially those that are common to all countries, and those which are peculiar to any particular region.*
>
> HIPPOCRATES: *On air, water and places.* § 1.

1. IMPORTANCE AND CAUSES OF PRESSURE AND WINDS.

Pressure forms the basis of the scientific study of meteorology; and winds form the principal controlling element of climate. The examination of the variations of pressure at a place does not give any clue as to the quarter from which the winds may be expected. For this purpose it is necessary to know the pressure in other centres of observation. It is different with winds. If, at any place, the direction of a wind be known, it is easy to say what kind of weather may be expected with that wind, in a particular season. This shows how important is the study of winds.

The sun is the principal cause of the differences in pressure; the moon has some influence, but compared

with the sun it is very insignificant. The main cause of variations in pressure is temperature, (Maps III e IV) due in the first place to the movement of the earth round the sun. Differences in pressure in the same latitude are dependent upon the geographical features and the amount of humidity in the air; differences in pressure give rise to winds; and the winds in their turn control the distribution of temperature and of humidity. Thus there is an intimate and beautiful correlation between the main factors of climate.

The centres of high and low pressure are styled «the centres of action».

The influence of ordinary variations in pressure upon health is not of great importance.

The *winds* control, as already stated, almost all the factors of climate. In those countries where there are regular seasonal winds from different quarters in different parts of the country they form a good basis for the division of the country into different climatic regions. Portugal, as it will be seen further on, is one of such countries.

The direction of winds gives, by what is known as the Buys Ballot's law, a good clue to the centre of depression. If the back be turned to the wind, and if the left hand be extended, the centre of depression lies nearly in the direction of the hand. The examination of the direction of clouds also gives a clue to the centre of depression.

Winds have been considered from the earliest times as synonymous with weather or climate. In the *Rigveda,* which contains the earliest record of the Aryan branch of mankind, there are several beautiful hymns addressed to Wind, under the names of Vâyu

and Vâta, one of which, composed by Ulâ, runs as follows:

«Filling our hearts with health and joy, may Vâta breathe his balm on us;
May he prolong our days of life,
Thou art our Father, Vâta, yea, thou art a Brother and a friend,
So give us strength that we may live...
The store of Amrit laid away yonder, o Vâta in thine home,
Give us thereof that we may live». (1)

In other hymns the Wind is addressed as «the envoy of God», as «the possessor of all the remedies», and as «the dissipator of all the evils».

Among medical writers, nobody has as yet studied better the influence of winds upon health and disease than Hippocrates.

2. PRESSURE IN PORTUGAL; INFLUENCE OF GEOGRAPHICAL FEATURES AND OF CLIMATIC FACTORS.

The geographical features, combined with the rotation of the earth round the sun, have an important influence upon pressure.

When the temperature rises the air expands and becomes lighter, and the place of the light air is occupied by the heavy air. Again, when the temperature rises, there is a greater evaporation of the watery vapour, and the watery vapour, being lighter than the air, increases its expansion and diminishes the pressure.

There are two great permanent centres of action: the equatorial and the polar, giving rise to the equatorial and the polar winds. Besides these there are other great centres of action depending upon the seasons, and the irregular distribution of land and water, which give rise to seasonal winds. And, lastly, there are local

centres, which give rise to local winds or breezes. The principle which gives rise to breezes forms also the basis of the ventilation of habitations.

In 40° N. *lat.*, or in about the latitude of Lavos and the Serra of Estrela, the mean annual pressure, reduced to the level of the sea is 762 mm., the mean in January being 763.7, and in July 762.0 (1). This pressure diminishes both northwards and southwards, so that the Serra of Estrela forms a line of separation between the northern and southern regions of Portugal. This line corresponds more or less with the line which is figured by Woeikof, (2) as joining the high pressure in Madeira with the high pressure in Russia, passing nearly through the centre of the Continent, and forming what is known as «the axis of Woeikof».

In ascending a *mountain*, the pressure decreases at the rate of 1 mm. per $10^{m.}5$ up the height of 2009 m., or up to the highest peak in Portugal. By means of this rule it is easy to calculate the approximate mean pressure of any of the mountains or the cities and towns the elevation of which is known.

The following table shows, in millimetres, the mean annual and seasonal distribution of pressure during 10 years:

	An.	Wt.	Spr.	Sm.	Aut.
Oporto......	765.74	757.52	754.71	755.05	755.31
Lisbon......	55.64	57.69	54.65	55.05	55.16
Lagos.......	62.70	65.46	61.68	61.78	61.87
Moncorvo...	27.10	28.09	26.90	26.33	26.98
Beja........	38.96	40.74	37.86	38.52	38.69

The differences in the mean pressures of the 5 stations depend almost entirely upon the differences in the altitudes (Ch. II. 9). Reduced to the level of the sea, the pressure is nearly equal throughout the country, except that it appears to be a little feeble towards the north.

The different power of absorbtion and radiation of temperature in different *soils* gives rise to differences in pressure.

The highest pressure occurs at the level of the *sea.*

Generally speaking, the pressure is lower in a *forest* than in the open country.

Pressure stands in an inverse correlation with *temperature.* During the day it diminishes with the rise of temperature and increases with its fall. It varies, for the same reason, according to months and seasons; it increases from summer to winter, and diminishes from winter to summer. Comparing winter with summer, Lagos presents a higher pressure in winter than at the other stations by 003,68.

It is of no practical use to note the pressure at the other 10 stations. It may be mentioned, however, that the pressure at Guarda is higher in summer by 000.53; and that at Montalegre it is also higher both in spring and in autumn than in winter by 001.12 and 000.21, respectively. The peculiarities are due to local causes.

Given the same temperature, the pressure above a certain height is lower on the sea than at the same height on land. This is due to a large quantity of *watery vapour* in the sea air.

In general terms it may be said that the barometre rises with the *winds* from the north and from the land, and falls with the winds from the south and from the sea.

An examination of the great seasonal centres of action in and around Portugal is essential in order to understand clearly the distribution of winds. M. de Bort has devoted one of his memoirs to the study of the circulation of air in the Iberian Peninsula (3).

In January a pressure bordering on 767 mm. has its centre in the Lusitanian Sea in or near Madeira, and there is also an area of high pressure, 766 mm. in the centre of Spain, both these centres being joined by a line of high pressure which passes through Portugal, more or less, along the chain of the Serra of Estrela. Towards the south, in the Mediterranean Sea, the pressure is low, nearly 762 mm., and a similar low pressure in found in the Bay of Biscay.

In July the maximum of pressure noticeable near Madeira in winter shifts northwards to the latitude of the Azores, 767 mm., where it spreads over a considerable portion of the ocean. There are two centres of low pressure, one of 760 mm. in the north of Africa, and the other of 761 mm. in the centre of Spain. In Portugal itself the pressure increases from the west to the east; it is 752 mm. along the coast and 764 mm. along the eastern frontier.

Taking the whole year round, the greatest point of interest is the seesaw sort of arrangement of pressure in the Lusitanian Sea. An increase of pressure from north to south in winter, and an increase from south to north in summer, there being a great amplitude of pressure over a large surface of the sea around the Azores. This is the key to the change in the regional winds in Portugal in winter as compared with summer.

The differences in pressure may be constant and annual, giving rise to equatorial and polar winds; they

may be constant and seasonal, giving rise to seasonal or regional winds; they may be casual, producing occasional winds; and, lastly, they may be local, producing the sea, the mountain, and the forest breezes.

Normal pressures give rise to normal types of weather.

3. GENERAL, REGIONAL AND OCCASIONAL WINDS; THEIR PREVALENCE AND VELOCITY.

Wind, as already stated, is nothing but the air in notion. The mechanism of all kinds of winds and breezes is the same. They blow from an area of high pressure to another of a low pressure, but owing to the rotation of the earth, those which start from the south and from the north in the northern hemisphere take, at first, a south- and a north-easterly direction, respectively; and, then, in the latitude of Portugal, the former becomes a south-west and the latter a north-west or a north wind. A similar deflection takes place in winds starting due east and due west. The greater the gradients, or the greater the proximity and the greater the difference in pressure of the isobars, the greater is, likewise, the velocity or the force of winds. Halley was the first writer to give a detailed description and a sketch of a circulatory theory of the Trade Winds and Monsoons (1).

Mountains, hills, or even a belt or tall trees, change the direction of winds and break their force. The configuration of a district or a town may be favourable or otherwise in accordance with its exposure to the favourable or unfavourable prevalent winds. As a rule, there is no place which is not exposed to some favourable

winds in one season or another. A high level wind may blow on a mountain without affecting the plain.

Winds at various altitudes in the air have not yet received any attention in Portugal. Their observation is of importance in aerial navigation. Owing to the ignorance of these currents some valuable lives were lost not long ago at Oporto.

1) The *general* winds are equatorial and polar. Their description is to be found in books devoted to general climatology. The most important point to notice in connection with them is that the equatorial wind becomes in the latitude of Portugal a low level wind, especially in winter.

2) The *regional* or seasonal winds are of greater importance in Portugal than the general, for they impress distinctive characters upon the climate of the regions in which they prevail. They are caused by the great seasonal centres of action already described. These winds blow sometimes in the same direction as the polar or the equatorial, and sometimes in the contrary direction in different levels. In Portugal, the equatorial wind below 40° N. lat. is, generally speaking, a high level wind and blows on high elevations; and the polar is a low level or surface wind and blows generally along the coast and on the plains. Above 40° lat. the equatorial wind blows in winter in the same direction as the seasonal; in summer it is a high level wind as in the south.

The study of the *prevalence* of winds at a particular station is of importance, as regards the station itself, but forms no sure guide to the prevalence of the winds in the region in which the station is situated.

If all the winds of the compass, together with the

calm (C), be reduced to 8 points and the calm, the percentages of the most prevalent winds in the months of January and July are as follow:

JANUARY.

Oporto	S.E.	27,	E.	23,	S.	13,	C.	11
Lisbon	N.	29,	N.E.	29,	N.W.	9,	C.	2
Lagos	N.	26,	S.E.	20,	E.	14,	C.	0
Moncorvo ..	E.	11,	N.E.	7,	S.	7,	C.	54
Beja	N.W.	19,	E.	19.	N.E,	16,	C.	1

JULY.

Oporto	N.W.	40,	W.	26,	N.	21,	C.	27
Lisbon	N.	30,	N.W.	27,	S.W.	14,	C.	5
Lagos	N.	63,	S.E.	18,	N.W.	15,	C.	0
Moncorvo ..	N.E.	25,	E.	14,	N.	7,	C.	29
Beja	N.W.	34,	W.	27,	S.W.	8,	C.	1

The percentages at some other stations are:

Coimbra:								
January ...	S.E.	23,	S.	14,	E.	14,	C.	5
July	N.W.	56,	W.	16,	N.	6,	C.	11
Guarda:								
January ...	N.W.	27,	S.	19,	N.E.	4,	C.	4
July	N.W.	37,	S.	19,	N.E.	11,	C.	6
Campo Maior:								
January ...	E.	39,	W.	14,	N.	8,	C.	0
July	W.	20,	E.	20,	N.	14,	C.	0

Montalegre:

January ...	N.	19,	E.	18,	N.E.	15,	C.	9
July	W.	32,	N.W.	16,	S.W.	15,	C.	6

It is easy to see, at a glance, how the different stations differ from each other. The N.E. wind which blows at Lisbon or in the Lusitanian Sea, in winter, is known as the *Portuguese* Trade, «an extension, according to Abercromby, of the true trade far beyond the limit of the tropics, but meteorologically identical with it» (2).

The scale adopted by the Meteorological Department in the description of the *velocity* of winds is: calm 0–1 km. per hour, breeze 1–4, very weak wind 4–7, weak 7–12, moderate 12–15, fresh 25–40, strong 40–50, very strong 50–60, tempestuous 60–70, and violent 70–100. In nautical language these terms are named: faint air, light air, light breeze, gentle breeze, fresh breeze, gentle gale, moderate gale, brisk gale, fresh gale, strong gale, hard gale, and storm (Beaufort).

The mean annual and seasonal velocities for 10 years, expressed in kilometres per hour, are:

		An.	Wt.	Sm.
Oporto	...	15.77	17.92	14.36
Lisbon........	...	18.12	17.33	19.58
Lagos	...	—	—	—
Moncorvo.....	...	—	—	—
Beja..........	...	12.1	11.2	12.8

At Coimbra the mean, in winter, is 15.2 and in sum-

mer 12.2; at Guarda 18.51 and 13.6; and at Campo Maior 8.58 and 9.35, respectively.

The velocity in moderate latitudes increases, generally speaking, from morning to aternoon in close relation with the temperature, and diminishes from afternoon to midnight, when it attains its minimum. In a similar way, it is also, ordinarily speaking, greater in summer than in winter. In Portugal, owing to the peculiar distribution of the centres of action, the velocity is greater in winter than in summer along the coast in the N. Atlantic region, above 40° lat.; and greater in summer than in winter in the Lusitanian region. The difference is due to the fact that at Oporto the seasonal and the equatorial winds have the same direction in winter.

The velocity of winds is not registered at Lagos or at Faro in the Mediterranean region, but it appears that it is more moderate than in the N. Atlantic or the Lusitanian regions. The N. Continental is a region of comparative calm; and the S. Continental region has more moderate winds than the Lusitanian. It has to be noticed, however, that Beja is situated far more inland than Oporto or Lisbon.

Wind increases in velocity in *altitudes* above the ground, for near the ground there are obstacles to its free circulation. In Paris the mean velocity at an elevation of 20 m., is 2 m. 15 per second, whereas at 302 m. it is 8 m. 70. In the plains, near the ground, the velocity decreases in accordance with the distance from the sea; it is comparatively very low at Campo Maior. In winter the velocity is higher at some stations of altitude situated inland, as at Guarda, than at the stations on the littoral. Under equal circumstances, it

is always greater on the *sea* than on land; and less in *forests* than in the open country.

Generally speaking, winds have, more or less, a horizontal direction. When strong or violent, they take an obliquely descending direction, as it is sometimes the case with the N. wind in summer; or they take an obliquely ascending course, as it is sometimes the case with the S.W. winds in winter.

3) The *occasional* or cyclonic winds depend upon greater variations in the high and the low pressures, and upon a steeper pressure gradient. One of the occasional winds blows on the coast of Algarve from the African desert for 2 or 3 days at a time and gives rise to a hot temperature. This wind extends, occasionally, up to the Serra of Cintra. The primary cause of this wind is supposed to be of electrical nature. The heated air ascends to a great elevation, taking with it a large quantity of suspended sand, and descends at any place with great violence, and acts injuriously upon the vegetation. There are occasional cold winds of some severity from the northerly direction.

4. SEA, MOUNTAIN, AND FOREST BREEZES.

1) The *sea-breezes* form, on the coast, a most important element of climate. Their mechanism is similar to that of the general winds. The pressure is low on land during the day and on the sea during the night, and, so, there is a breeze on-shore during day and off-shore during night. These currents in the low level are accompanied by counter currents at a high level.

The sea-breezes are frequent in summer, but they are not entirely absent in winter. They rise to a height of

130 to 150 m., whereas the return counter-current rises to 200 m. or more. On some portions of the coast, as that of Algarve, the breezes follow the course of the sun. They blow from the east in the morning or at sun-rise; they blow from the south during the day; from the west in the evening; and from the north, or from land, during the night; hence their name «viração», or the changing breeze.

The extent of the sea and the land breezes depends upon the configuration of the country. When the land slopes more or less towards the sea their influence may be felt, in each direction, up to distance of 40 to 50 km. from the coast. When there are hills, as along the coast of the S. Continental region, they do not penetrate far inland. When the slopes are very favourable, as in the southern side of the Serras of Arrabida and of Monchique, the land and sea-breezes are strongly developed.

Besides the sea and the land breezes there is a considerable movement of the air near the coast due to tides and waves. Both these may be compared to the movements of a huge fan.

2) The *mountain* breezes are likewise produced by a mechanism similar to that of the sea and land breezes. During the day there is a low pressure on the top of mountains, and so the breeze blows up the valley; during the night there is a low pressure in the opposite direction. In some of the narrow valleys in the N. Continental region, where the mountains run from north to south, and the side of one mountain is exposed to the sun in the morning and that of another in the afternoon, there are currents of breezes in the morning from east to west, and in the afternoon from west to

east. They may be styled «intermountain breezes». These currents are feeble when the mountains are covered with snow, and the valleys are shallow.

In some situations, as the southern side of the Serra of Arrabida, where the mountain borders on the sea, the mountain breezes blow down to the sea at an acute angle, and the sea breeze rises up the mountain. The velocity of these breezes is often greater than that of those on the plains, for the differences in pressure are also greater. These breezes, termed the «rockwind» by fishermen, form a sort of belt at a short distance from the coast, and present an obstacle to the entrance of the boats into the harbour.

3) Where there are large forests, and large open spaces in its neighbourhood, local currents of air may be established between the *forest* and the open country during the day, and in the reverse direction during the night. A forest or even a well-placed belt of tall trees have a decided influence in changing the direction of a breeze and of modifying its velocity. There is a greater calm in a forest than in the open country.

The breezes may blow in the same direction as the general or seasonal winds or they may blow in the opposite direction. In the former case their velocity is greatly increased; in the latter they are overcome or replaced by the stronger currents.

The winds and breezes are not felt to the same extent in a crowded *city* as in the open country. In laying out streets, or in building a house or a hotel, it is necessary to study carefully the direction and the nature of the prevalent winds and breezes.

5. DIVISION OF PORTUGAL INTO REGIONS BASED UPON PRESSURE AND WINDS: ISOBARS AND ARROWS.

This is a subject of great importance, and has to be considered in some detail. Places having the same pressure, reduced to the sea-level, are united by lines termed isobars; and winds are represented by arrows of various lengths and sizes, showing their direction and their velocity.

The Portuguese portion of the axis of Woeikof, or the isobar of high *pressure,* separates the country into two main divisions: the northern and the southern, the line of division running through the chain of the Serra of Estrela.

Local centres of action separate the N. Continental from the N. Atlantic regions, and the Mediterranean from the S. Continental. There is no definite line of division between the Lusitanian and the S. Continental regions.

In Spain the axis of Woeikof passes through the northernmost part of the country and not nearly through the centre as in Portugal.

Winds may be classified according to their prevalence and velocity. They may be further classified according to their humidity and temperature.

The frequency of winds registered at two or three stations in a large province is not of much use as a basis of classification of the prevalence of winds in that province, for places at very short distances register, owing to their configuration, different directions of winds although proceeding from one and the same point of compass. At Oporto, for instance, the fre-

quency of winds registered at three stations are: at the Observatory of the Serra do Pilar: S.E., E.S.E., and E.; at the Observatory of the medical School, only 1.5 km. distant from the preceding: E., S.E., and E.; and at the Torre d'Anjos, at the Foz do Douro: N.W., S.W., and S.E. A similar example is also noticeable on the coast of Algarve. When there is a N. wind at the Cape of St. Vincent there is often the S.E. at Faro, and the E. and N.E. at Albufeira and Lagos. The difficulty of determining the real origin of winds is at times so great that their nature is better determined by the amount of moisture they contain than by their actual direction.

Another circumstance which renders the winds registered at one or two stations useless as a basis of classification is the prevalence of breezes. A S.W. wind blowing on the coast, for instance, may be a seasonal wind or it may be a breeze. There is no way of distinguishing the two by the examination of the register. In a similar way a land wind may be confounded with a mountain breeze or vice-versâ.

Owing to these difficulties, it is necessary to look at the distribution of the prevalence of winds in a country from a wider standpoint: from the position of the isobars, or from the distribution of the great centres of pressure; and from the direction of the winds as they blow in the open, where they meet with no obstacle to change their direction.

Taking the winds in *winter* as the basis, Portugal may be divided into two parts: one to the north of the Serra of Estrela, under the S. and the S.W. winds, and the other to the south, under the N. and the N.W. These are the prevalent winds in the north and in the

south of Woeikofs axis. Between the northern and the southern regions there is a zone of variable winds, or, in other words, a portion below 40° of lat. lies within the zone of the winter, and a portion above 40° within the zone of N. winds in summer. No actual limit can be fixed.

If all the mountains in the north had a N. E. to S. W. direction, as those forming the valleys of the Mondego and the Vouga, the S. W. winds would penetrate up to the frontier. But such is not the case. The Serras ot Montemuro and of Marão shut in or act as a screen to the perflation of the S. W. winds into the province of Traz-os-Montes, and so two distinct regions are formed: one the *North Atlantic,* under the S. and S. W. winds, and the other the *North Continental,* to which these winds have no free access.

Again, if the whole country to the south of the Serra of Estrela were a simple plain, the N. and the N. W. would be the prevalent winds all over. But the Serra of Algarve acts as a screen to the perflation of these winds southwards, and so a distinct region, the *Mediterranean,* is formed, consisting of all the area to the south of the Serra. The prevalent winds in this region are the S. E. and the S.

Lastly, the country lying between the Serra of Estrela and the Serra of Algarve has the N. and N. W. as the prevalent winds, but as the country above the valley of the Tagus, including the portion to the north of the Bay of Setubal and of the Ribeira Grande, consists mostly of mountains, the *Lusitanian* region is under the inflluence of the N. and N. W. winds in the plains and of the S. and S. W. winds in the highlands, for the former are, in the latitudes of this region, low

level winds, and the latter high level winds. The direction of these winds are sometimes beautifully exemplified by the cloud: the low level clouds running from the northerly to the southerly direction, and the high level clouds in the opposite direction. The region between the valley of the Tagus and the Serra of Algarve or the *S. Continental* region has no high mountains, and its prevalent winds are the N. and N. W. It is difficult to draw a distinct line of demarcation between this and the Lusitanian regions, on the northern side. For the sake of convenience the Serra of Ossa is taken as the boundary line, running westwards to the Serra of Palmela, and eastwards by a line drawn through the crest of the Serra of San Mamede up to the frontier, separating the basin of the Sorraia from that of the Guadiana.

During *summer*, the centre of high pressure passes to the latitude of the Azores, and as a consequence the prevalent winds in the N. Atlantic, the Lusitanian and the S. Continental regions are the N. and N. W. In the Meditereanean region the prevalent winds are the N.; and in the N. Continental, the Calm and N. E. The winds in summer being, more or less, common to all the regions, have not the same importance as those in winter. But, all the same, above 40° lat., the influence of the S. W. winds is felt, even in summer, more than below it.

Each of the 5 regions has, besides the seasonal winds, some characteristic features as regards its *breezes*. In the N. Atlantic region, owing to the large number of mountains and their proximity to the sea, the mountain and the sea breezes are extremely well developed. The same thing occurs in the Mediterranean region. In the Lusitanian region, if the Serras of

Cintra and Arrábida be excluded, the mountainous area is more inland and so there is no interchange between the sea and the mountain breezes as in the preceding regions, but on the other hand, the peninsulas of Cape Roca and Cape Espichel are much influenced by the sea-breezes. In the N. Continental region there are mountain and valley breezes; whereas in the S. Continental these are replaced, towards the coast, by feeble sea-breezes, which, owing to the dunes and the Serra of Cercal, do not affect any important population.

The prevalence of distinct winds and of breezes in the 5 *regions* may be summarised as follows:

The N. Atlantic: S.W. and S.; mountain breezes, well developed and approaching the coast.

The Lusitanian: N. and N.W. in the plains; S.W. in the highlands; mountain breezes receding from the coast; sea-breezes well developed.

The Mediterranean: S. and S. E.; mountain and sea breezes very well developed.

The N. Continental: Calm and N.E.; mountain, intermountain, and valley breezes.

The S. Continental: N. and N.W.; sea-breezes feeble.

The sea-winds blowing through the valleys of the Vouga, the Mondego and the Zézere meet in the district of Guarda.

From the figures quoted in § 3, it is clear that the winds in Portugal, considered as a whole, are moderate.

The influence of winds in the distribution of humidity and temperature will be described in the following chapters.

The circulation of winds in January and February (1) in the south of England and of Ireland is under the same regimen as the N. Atlantic region of Portugal, so

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that, barring the differences in latitude, there is a great similarity in the climate of the respective regions of the two countries. The most prevalent winds, in winter, at Guardia are the S. W., and S. S. W.; and at Badajoz the N. W. and N. E.

Some writers believe that the winds in Lisbon and in Portugal are strong and at times violent. This does not hold good when applied to all the seasons and to the whole country. Fitzroy pointed out long ago that «from Portugal to Iceland, to the Isles of Scotland, and to Norway, greater variations, stronger winds, and less settled weather prevail, even in summer, *as latitude increases*» (2). In the north of Spain there is a popular proverb which says:

El viento gallego
Es la scoba del cielo,

or «the Gallician wind (which is very strong) acts like a brush from heaven». It may be laid down that the winds in Portugal are more moderate than in all the countries to its north.

The prevalent winds in the Mediterranean region of Portugal are similar to those of the southern coast of Spain and of France, but the Portuguese coast is almost free from the solano on the south and the south-eastern coast of Spain, from the mistral on the south of France, and from the sirocco of Southern Italy. Compared with the southern coast of France, the winds in Lisbon are more moderate in winter (3). The winds in Portugal are fresh along the coast sometimes in summer, and occasionally in winter.

6. EFFECTS OF PRESSURE AND WINDS UPON MAN.

The influence of the ordinary diurnal and seasonal changes in pressure is not well understood. Some persons appear to be susceptible to its action, but the effect may be due to the electrical and other changes which are coincident with great depressions.

The pressure of the atmosphere on each cubic centimetre of the surface of the earth is $1,033^{\text{gm}}.6$; and the pressure supported by the human body at the sea-level is 17,500 kgm., which is reduced to 9,800 kgm. at an altitude of 4,500 m.

A high pressure, as on the sea-shore, combined with other climatic factors, has the effect of rendering slower the circulation and the respiration. It gives rise to greater oxygenation of blood, and acts as a tonic and a sedative. When the pressure is excessive it gives rise to the «caisson» disease or the divers' paralysis. A pressure of 20 atmospheres gives rise to convulsions and death due, according to Bert, «to the excess of oxygen» (1). It has been noticed that there is some relation between high pressure and the frequency of apoplexy.

A low pressure, as observed on high altitudes, has a contrary effect. The balance between the internal and the external pressure is lost. There is less oxygenation of blood. When the pressure is excessively low, it gives rise to mountain sickness, bleeding from the nose, and a tendency to pulmonary hemorrhages. The mountain sickness is noticeable at an altitude of 3,500 to 4,000 m.

In general terms, a high pressure when it exceeds a certain amount is depressing; and a low pressure

within certain limits is stimulating. When there is a rise or a fall of pressure certain nervous and asthmatic persons feel relieved or aggravated. Constant depression diminishes the digestive powers. A low pressure is useful in those complaints in which it is necessary to reduce the pressure of blood towards the lungs.

Mr. Dexter has correlated a high pressure with an increase in crime, insanity, bad conduct, sickness, and suicides; and a low pressure with a decrease in drunkenness and in clerical errors (2).

Different persons show different capacities to bear the various *pressures* or *forces of wind*. Generally speaking, moderate winds are more agreeable than either the calm or strong winds. Delicate and feeble persons cannot bear strong winds. Some neurasthenic and hysterical persons do well under strong winds. Strong winds hinder free and easy respiration.

The force of winds has a great influence in determining the sensations due to moisture and temperature.

The pressure of wind upon the human body is in proportion to the square of its velocity.

Velocity of winds in m. per second.	Pressure in kgm. on one sq. m.
1 m.	0.125 kgm.
2	0.500
3	1.125
4	2.000
10	12.500
20	50.000
40	200.000

In general terms, it may be said that the winds from the sea are more favourable to health than those from

land, and the winds on mountains are more favourable than in the plains. In Portugal, the N. and the S. winds are favourable to health, especially the former ; the N. E. and the S. W. are unfavourable; the N. W. and the S. E. are suspicious; the W. is very favourable; whereas the E. is very unfavourable. As regards breezes, those which proceed from the sea, the mountains and the forest are, comparatively speaking, more favourable than those which proceed from land, valleys, and open spaces. The velocity being the same, the influence of the winds and breezes depends upon their temperature and humidity.

The winds have a great influence in cleaning the atmosphere of its impurities. Under unfavourable circumstances, they may be the conveyors of impurities, such as smoke, dust, &c. The influence of winds in conveying the germs of diseases is not so great as it was believed to be formerly.

As a rule, a considerable air movement is stimulating; a mild wind or a breeze is sedative; and the absence of winds or calms are enervating or depressing.

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CHAPTER V.

HUMIDITY, RAIN AND NEBULOSITY.

Without watery vapour the air is irrespirable.

1. IMPORTANCE OF HUMIDITY.

Water may be present in the air and on the ground as vapour, liquid or solid. Of all these forms, the invisible vapour in the air is the most important. Air without watery vapour is irrespirable. A certain amount of atmospheric humidity is just as essential to life as a certain degree of atmospheric temperature. Next in importance to the watery vapour, and a long way off, is the annual amount and distribution of rain. Then comes nebulosity, or the amount of mist, fog and cloud. And, lastly, follow snow, hail, frost, and dew.

The invisible vapour of water forms one of the variable constituents of the air. Its presence and its importance is not so self-evident as that of the temperature of the air. Tyndall was the first to show how it exerts an extraordinary energy as a radiant and as an absorbent of heat; and how a large quantity of watery vapour in the air shields the earth from the sun's heat by day, and from the chilling effects of its own radiation by night (1).

The presence of the watery vapour in the atmosphere

is due to evaporation. The evaporating power of the air has an important influence upon the human frame.

2. EVAPORATION OR THE CAUSE OF HUMIDITY.

The following table shows, in millimetres, the mean amount of *evaporation* during ten years.

	An.	Wt.	Spr.	Sm.	Aut.
Oporto	829.4	155.3	218.9	251.3	203.9
Lisbon	1047.3	89.0	283.6	475.8	198.7
Lagos	—	—	—	—	—
Moncorvo	—	—	—	—	—
Beja	2214.3	183.4	508.9	1036.5	485.5

The respective figures for Coimbra are: 2188: 313, 528, 803 and 488; for Guarda, 1201: 178, 368, 726, and 284; and for Campo Maior, 2297: 395, 676, 1058, and 561.

The evaporating power of the air depends upon pressure, upon the amount of watery vapour already existing in the air, upon the degree of temperature, and upon the force of winds. The differences between all the stations depend upon one or more of these causes. The evaporation increases from the northern latitudes to the southern; and it is greater in high altitudes than in the plains.

In winter the evaporation at Oporto is a little less than twice that at Lisbon, but in summer it is quite the reverse. At Beja the amount is somewhat more than

that at Oporto in winter, and it is four times more in summer.

It has been calculated that the extent of surface required for the production of a ton of salt in the salt-pans near the Tagus is 56 sq. metres, whereas at Aveiro it is 286, and near the Sado only 33.

3. HUMIDITY: ABSOLUTE AND RELATIVE.

Absolute humidity is the amount of watery vapour by weight in a given volume of air. The following table shows in millimetres the mean vapour tension or vapour pressure calculated from 3 observations a day during 10 years. The millimetres represent also, approximately, the weight of the vapour in grams in a cubic metre of air.

	An.	Wt.	Spr.	Sm.	Aut.
Oporto	10.23	7.44	9.21	13.43	10.84
Lisbon	0.31	7.61	8.32	11.19	10.13
Lagos	10.33	8.44	9.23	12.43	11.24
Moncorvo	9.13	6.70	8.36	11.71	9.75
Beja	8.79	7.23	7.92	10.35	9.66

The annual means at the other stations are: Coimbra 9.07, Guarda 6.66, Montalegre 6.98, Estrela 5.72, S. Fiel 7.46, Faro 11.48, Evora 13.1 (2 observations a day). Vila Fernando 8.72 (2 observations).

At all the stations there is more absolute humidity in summer than in winter, and more in autumn than in spring. The air at Lisbon contains less mean annual

amount of moisture than that at Oporto or Lagos. In winter Oporto has less amount of moisture than Lisbon, but more in all the other seasons.

The monthly absolute humidity is at its maximum at Beja in August, and at all the other four stations in July; the minimum at all the stations is in January. At Coimbra the maximum is in August and the minimum in December.

Relative humidity is the phrase used to indicate the quantity of watery vapour in a certain volume of air, expressed as the percentage of the amount that the same quantity of air at the same temperature and at the same pressure could possibly hold when completely saturated. Usually the term *humidity* means relative humidity.

The mean relative humidity, calculated from three observations in 24 hours, at the 5 stations during 10 years, is:

	An.	Wt.	Spr.	Sm.	Aut.
Oporto	77.5	80.7	74.3	74.9	79.9
Lisbon	61.8	70.0	59.1	53.5	63.8
Lagos	66.6	75.0	63.6	59.4	68.2
Moncorvo	68.8	87.7	66.3	50.0	71.4
Beja	64.4	77.8	63.3	49.3	67.3

The mean annual at the other stations is: Coimbra 72 (mean of hourly observations), Guarda 66, Montalegre 65, Estrela 68, San Fiel 56, Faro 72, Evora 83 (2 observations a day), and Vila Fernando 58 (2 observations).

If San Fiel and Vila Fernando be excluded, Lisbon has a lower mean annual relative humidity than all the other stations. In winter it has 10 p. c. less than Oporto, and 5 p. c. less than Lagos. The yearly fluctuation, or the difference between the most humid and the least humid months, is as follows: Oporto 13.0, Lisbon 22.4, Lagos 21.0, Moncorvo 44.3, and Beja 34.4. The apparent anomaly of Lisbon as regards its relative humidity is due to the winds.

The relative humidity calculated from observations taken 3 times a day gives a lower mean than that calculated from 24 or hourly observations. The difference between the two as regards Lisbon is about 5 p. c. This is probably the reason why Coimbra presents a higher relative humidity than some of the other stations.

At all the five stations December is the most humid month and July the driest. Coimbra presents the greatest humidity in November and the least in August. Broadly speaking, the mean monthly humidity in March, and the mean between the middle of September to the middle of October, correspond with the mean annual. From November to the commencement of February there is less variation at Lisbon from month to month than at the other stations, or in other words, in autumn and winter there is greater tendency to dryness than to humidity.

The variation of humidity during the day is nearly inverse of the variation of temperature. It stands at its maximum at sunrise, diminishes to its minimum at about 14 o'clock, increases rapidly towards the evening, and very slowly during the night.

In summer the relative humidity diminishes towards

the centre of the peninsula, so that it is about 20 p. c. less at Madrid as compared with Lisbon; in winter it is frequently near the point of saturation at the former city, and 70 p. c. at the latter. In winter, at Guardia it is 84 as compared with 80 at Oporto; and 76 at Badajoz as compared with 74 at Campo Maior. The relative humidity in London is 84, rising to 90 at Tottenham and falling to 80 at Kew.

4. RAINFALL: AMOUNT AND FREQUENCY.

Although the *rainfall* in a country is not of such importance in medicine as the atmospheric humidity, still its amount and distribution form a good guide to the relative humidity and also to the other aqueous phenomena; it forms likewise a good guide to the amount or intensity of vegetation.

The mean *amount* of rain (Map V) in millimetres observed during 10 years is:

	An.	Wt.	Spr.	Sm.	Aut.
Oporto...........	1233.6	477.7	291 4	121.1	343.4
Lisbon...........	640.7	259.9	145.7	39.9	195.0
Lagos............	478.6	181.0	91.6	20.2	185.8
Moncorvo........	529.9	173.6	133.1	61.3	161.9
Beja..............	594.3	207.2	160.7	26.9	199.5

The mean amount of rain at the other stations are: Coimbra 893^{mm}, Guarda 890, Montalegre 1162, Es-

trela 2773, San Fiel 663, Faro 391, Evora 594, Campo Maior 545, and Vila Fernando 625.

The annual amount of rainfall is nearly twice as much at Oporto as at Lisbon, and three times as much as at Lagos. At Moncorvo and Campo Maior it is about the same, and about one-half of that at Oporto. If all the 15 stations be considered ensemble, Estrela has the highest amount, and Faro the lowest.

At the stations near the littoral the rainfall increases, proportion for proportion, in winter and spring, from Oporto to Lagos; whereas in summer it is proportionately much more at Oporto. Lagos, Campo Maior and Coimbra show a tendency to a greater rainfall in autumn than in winter.

At Oporto the maximum amount of rain is in December, and at the other 4 stations it is in November. This confirms the popular proverb:

De todos os Santos ao Natal,
É inverno natural;

or, «the real winter lasts from All Saints' Day to Christmas».

At Oporto and Lisbon the minimum is in July; at the other 3 stations it is in August.

Broadly speaking, it rains in winter in the morning; and in summer in the afternoon. The statistics at Coimbra show that it rains more at 6 o'clock and between 16 and 18 o'clock, and the least between 11 to 13 o'clock.

There is a close connection between the absolute humidity in the air in summer and the amount of rain in that season.

Of all the climatic factors the amount of rain varies through the widest limits and with the greatest irregularity, so that a true average requires a prolonged observation. The mean rainfall, for instance, in Lisbon during 74 years is $729^{mm.}$, the minimum being 344 in 1837, and the maximum 1341.5 in 1895.

The *frequency* or the mean number of days of rainfall during 10 years at the 5 stations is a follows:

	An.	Wt	Spr.	Sm.	Aut.
Oporto..........	158.1	47.7	42.3	22.6	45.5
Lisbon.....	113 6	42.7	30.4	8.8	31.7
Lagos............	57.4	21.7	12.2	3.5	19.7
Moncorvo.........	128 6	40 5	36.1	16.2	35.8
Beja........... .	111.2	39 8	33.7	8.2	29.5

The number of days of rain stands more or less in proportion to the amount of rain. Faro has the least number of days, and Oporto the highest. The mean number of days for the whole of Portugal, during the year, is about 100.

The distribution of rain in Portugal and its influence upon agriculture has been studied by Prof. Almeida Figueiredo (1).

The rainfall is at its maximum in November and December; and at its minimum in July and August. In the centre of the Peninsula the maxima occur in May and November, and the minima in July. Along the western coast of the Peninsula the amount of rain increases from the south of Portugal towards Gibraltar;

and from the north of Portugal towards Coruña; so that in the south it is 478$^{mm.}$ at Lagos, 600 at Cadiz, and 822 at Gibraltar; and in the north it is 1233$^{mm.}$ at Oporto, 1496 at Guardia, and 1814 at Santiago. The rainfall diminishes in proceeding towards the centre of the Peninsula: at Salamanca it is one-third of that at Guarda; and at Badajoz one-half of that at Campo Maior. In Great Britain there is, generally speaking, little variation in the amount of rainfall; the maximum is in October and November, and the minimum in June. The amount of rain in London is 704$^{mm.}$; and the number of days per year is 167.

5. NEBULOSITY: MIST, FOG AND CLOUD.

Mist and cloud consist of water in the air in a visible form; a fog is a dense mist combined, in large or manufacturing cities, with a good deal of smoke.

The mean number of days of *mist* in 10 years is as follows:

	An.	Wt.	Spr.	Sm.	Aut.
Oporto...........	80.9	19.5	16.6	20 3	24.5
Lisbon...........	24 8	12.8	2.5	1.8	7.7
Lagos......... ...	0.2	0 2	0.0	0 0	0.0
Moncorvo........	26.9	14.3	3 2	1 1	8 3
Beja.............	22.2	12.8	2 0	1.0	6.4

The number of days of mist at some of the other stations is: Coimbra 70, Guarda 78, Montalegre 18, Campo Maior 19, and San Fiel 30.

Practically speaking, there is no mist at Lagos, but it is frequent at Oporto.

Mists are often damp, but sometimes they are dry, that is, they have no influence on the hygrometre.

Real *fogs* are very rare in Portugal. They are frequent in London and other manufacturing cities the climate of which is moist.

Clouds are represented by figures from 0 to 10, 0 indicating the entire absence of clouds, and 10 indicating the whole sky covered with clouds. The mean annual prevalence of clouds is practically the same at all the stations. Oporto shows 4.5, Lisbon 4.0, and Lagos 4.2. The maximum at all the stations is in winter and the minimum in summer; spring and autumn are almost alike.

The clouds affect the climate in two ways: in preventing the sun's rays reaching the earth, and in reducing terrestrial radiation.

The nebulosity of England is between 6 and 7; and that of the west of Ireland, between 7 and 8.

6. SNOW, HAIL, FROST AND DEW.

Snow has not the same importance in Portugal as in other countries. The mean number of days during 10 years is: Oporto 19, Lisbon 2, Lagos 0, Moncorvo 0 and Beja 9. At Coimbra it is 19, Guarda 31, Montalegre 23, Estrela 36, and Campo Maior 16. The snow on the coast of the Lusitanian region is rather a meteorological curiosity. At Lisbon it does not lie on the ground even for a few minutes. At Estrela it lies for 6 months. The nearest elevation in relation to Lisbon where it lies for a few days is Monte Junto.

In comparing the Mediterranean region of Spain, which is in the same, or below the, latitude of the Mediterranean region of Portugal, there is a circumstance of capital importance in the determination of the climates of the two regions. In Portugal there is no mountain covered with snow, in winter, in the proximity of Algarve; whereas Andalusia and Granada have several such mountains.

Hail is more frequent in March than in any other month.

As regards *frost*, Oporto has in 10 years a mean of 0.7 days, Lisbon and Lagos, none, Moncorvo 13.6, and Beja 2.3. Coimbra has 7, Guarda 19.5, and Campo Maior none.

Dew has not the same importance in medical climatology as in the agricultural. It is more frequent in autumn and in spring than the other seasons.

7. INFLUENCE OF GEOGRAPHICAL FEATURES UPON HUMIDITY.

The amount of evaporation diminishes from the lower to the higher *latitudes*. The Lusitanian region occupies an intermediate place. The relative humidity is higher in the two northern than in the three southern regions. The Lusitanian region presents, as judged by its stations, the lowest percentage. The excess of rainfall in the N. Atlantic region is out of all proportion to the Mediterranean. The number of days of rain is, as compared with that in the Mediterranean region, three times more in the N. Atlantic, twice more in the Lusitanian, and somewhat more in the N. and S. Continental regions. Mist, cloud, and snow increase from south to north.

The influence of *altitude* upon humidity depends greatly upon the exposure. The south-western sides, or those exposed to the sea, are more humid than the north-eastern or those exposed to the land. At Guarda the amount of evaporation is one-half of that at Coimbra or Campo Maior. The relative humidity is less at Guarda, Montalegre and Estrela or at an elevation of 300 m. or upwards, than at San Fiel or at the level of the sea in places situated inland. The nights are moister than the days near the ground, but it is just the reverse at an altitude of 700 m. above the ground. In higher altitudes winter is drier than spring and summer.

The rainfall in altitudes is greater than in plains; it is four times more at Estrela than at San Fiel; and twice more at Montalegre than at Beja. Mists are generally found in valleys, but they are much more frequent at Guarda than at San Fiel. Cloudiness increases in some mountains and decreases in others. At Guarda and Montalegre it is less than at Coimbra. As a rule snow falls one month earlier and one month later in altitudes than in plains.

Other conditions being equal, the amount of evaporation depends upon the amount of moisture of the *soil*. The relative humidity is greater in marshy soils. The rainfall diminishes with the height above the ground. The nature of the soil has some influence in the distribution of mist, dew, snow, and frost.

Other circumstances being the same, there is greater evaporation from a given surface of fresh *water* than that of the sea; for the latter has a higher specific gravity. Absolute humidity is greater over the sea than over the land. Relative humidity increases in

proceeding inland in winter, so that it is nearly at the point of saturation at Madrid. It rains more on the sea than on the plains, but it rains less in the proximity of large rivers.

On the coast the maximum of rain occurs generally during night, and the minimum between 10 and 16 o'clock; in the interior or inland places the principal maximum is in the afternoon, and the secondary maximum is in the night or early morning, the chief minimum being between 10 to 14 o'clock. The surface of marshes is not covered as frequently with mist as the layer of air at a certain elevation. The deposition of dew is less frequent near the coast than in inland plains and in deep valleys.

A good deal of *vegetation* retains a greater amount of moisture in the ground and prevents free evaporation. A striking example of this fact is furnished by Brito Capello. From 1881 to 1885, when the botanical garden around the Lisbon Observatory was being planted, the mean annual evaporation was $1567^{mm.}$; but from 1891 to 1895, when the arborisation was quite complete, the mean fell to $1116^{mm.}$, the decrease being nearly 30 p. c. In a forest there is a great deal of evaporation of watery vapour from the leaves, and the relative humidity is 3 to 10 p. c. higher than in the open country. It has been calculated that the surface of leaves, laid side by side, would cover three to four times the surface of the ground covered by trees.

Forests intercept rain, their influence is local and not cosmic. Prof. Augusto de Figueiredo gives a good example of the local influence of trees upon the rainfall. There are two rain gauges at the Lisbon Observatory: one placed on the ground, and the other at an elevation

of $21^{m}.2$. Before 1883, or before the botanical garden was laid out, the amount of rain registered in the lower raingauge was, excepting one occasion, always less than that in the higher, but from 1883 to 1893, the conditions were reversed, the mean annual in the lower was $43^{mm}.54$ more than in the higher (1). Another example of the same kind is furnished by Souza Pimentel. The amount of rainfall at S. Pedro de Muel, in open ground, is $571^{mm}.3$; in the forest, $4^{km}.7$ inland, it is 723.4 or $152^{mm}.1$ more (2). Pine forests give rise to a greater amount of rainfall than forests with trees with flat leaves; they give rise also to more dew. It is partly due to the influence of vegetation that the rivers in Portugal are better supplied with water than those in Spain.

The rapid cooling of meadows at nights gives rise to mists and dew.

Generally speaking, in crowded *cities* the evaporation from the ground is less, and the atmospheric humidity is greater.

8. WINDS AS CONTROLLERS OF HUMIDITY.

All other conditions being the same, it is the force of the winds that regulates the amount of *evaporation*.

A table on the next page shows the absolute and the relative humidities, and the extent of clouds at Lisbon during January and July; and also the mean amount of rainfall at Lisbon and at Coimbra, corresponding with winds from each point of compass.

At Lisbon the S. S. W., in January, shows the maximum amount of *absolute humidity*, which decreases gradually in passing through the points of compass in

the western and northern direction on one side, and in the southern and eastern direction on the other, attaining the minimum exactly in the opposite direction: the N. N. E. The frequency or the duration of the winds from different directions explains why the absolute humidity is less in January, February and March, than in October, November and December.

TABLE.

	Lisbon: January			Lisbon: July			Rain	
	Abs. hum.	Rel. hum.	Clouds	Abs. hum.	Rel. hum.	Clouds	Lisbon	Coimbra
N.......	6.87	75.0	3.2	11.12	58.3	1.1	13.8	11.0
N. N. E.	6.30	73.5	3.2	10.24	51.4	0.8	26.0	1.7
N. E....	6.85	79.0	5.3	7.91	32.7	3.8	23.3	2.4
E. N. E.	7.62	87.6	7.8	—	—	—	20.2	7.6
E.......	7.79	80.5	4.8	—	—	—	16.7	20.0
E. S. E..	8.15	81.7	8.2	—	—	—	29.3	39.5
S. E...	—	—	—	—	—	—	24.7	49.9
S. S. E.	8.97	85.1	9.9	—	—	—	39.8	139.8
S.......	8.73	83.0	7.9	—	—	—	60.7	94.8
S. S. W.	9.20	84.9	8.0	12.81	76.3	4.7	115.0	108.1
S. W...	8.56	82.8	7.9	12.98	71.4	2.6	82.0	54.2
W. S. W.	8.77	81.8	7.4	12.78	69.0	3.8	74.6	99.7
W......	7.87	81.7	8.1	12.26	71.1	4.4	26.5	77.9
W. N. W.	7.89	80.5	7.0	11.78	68.1	4.7	35.8	153.5
N. W...	7.56	79.0	4.9	11.77	66.8	2.7	19.9	67.9
N. N. W.	7.13	75.4	4.3	11.62	63.6	1.1	20.7	32.1

The amount of humidity corresponding with winds from each point of compass depends, in each season,

upon the nature and the extent of the surface over which it has travelled. The N. N. W., for instance, is not accompanied in winter by as much humidity as the S. S. W., for it has traversed, so far as Lisbon is concerned, over a limited area of the sea, and a region of cold temperature; whereas the S. S. W. has proceeded from a much warmer region and traversed a larger surface of the ocean. The influence of surface is further exemplified by winds at Vizeu and Pinhel. The S. W. winds are generally moist, but they are dry at these places, owing to the fact that they have traversed the Serra of Estrela, and deposited their moisture there.

The mean *relative humidity* in January appears to be somewhat higher with the S. S. E. than with the S. S. W.

Dry and warm winds increase the absolute and diminish the relative humidity, whereas dry and cold winds have a contrary effect: they diminish the absolute and increase the relative humidity.

The maximum amount of *rain* during the whole year in Lisbon comes from the S. S. W., and the minimum from the N. At Coimbra the maximum corresponds with the N. N. W. and the minimum with N. N. E. At Oporto the general characters of winds are similar to those at Lisbon, but the winds from the S.W. contain more moisture, and those from N. E. are drier.

As regards *clouds*, their maximum occurs with the S. S. E. and their minimum with the N. and N. N. E.

There are more *mists* when the winds are feeble or calm, than when they are fresh or violent.

Taking the four cardinal winds as the bases, their influence upon humidity may be summarised thus: the southern bring in clouds and rain, and increase the

atmospheric humidity; the northern drive away clouds and rain, and render the air dry; the eastern are very dry; and the western give rise to storms and rain, and render the air moderately moist.

Portugal as a whole is exposed to the equatorial and the polar winds, both of which contain a good deal of moisture. In autumn the rain comes usually from the N.N.E. quarter, and in March from S.S.W.

9. INFLUENCE OF TEMPERATURE UPON HUMIDITY.

All conditions being the same, the amount of evaporation and of absolute humidity depends upon the degree of temperature. A progressive decrease of temperature converts the air saturated with invisible vapour into the visible, then into liquids, and finally into solids. A progressive increase of temperature applied to solids has a contrary effect.

The percentage of relative humidity, given the same amount of absolute humidity, depends entirely upon temperature. A percentage of 60 at a temperature of 5° is reduced to only about 10 in raising the temperature to 28°. It is due to temperature that the relative humidity is less during the day and in summer, than during the night and in winter.

Mists do not rise above a certain level, for above a certain level the temperature is higher than below or near the ground. Due to the greater differences in the temperature of the sea and of the air, there are many more days of mist in the N. Atlantic region than in the Mediterranean.

The amount of humidity in the air reacts upon the temperature, as it will be seen in the next chapter.

If clouds charged with a good deal of moisture arrive in a comparatively warm region, the amount of rainfall is none or is less than if they flow in a cold region. This explains the rainless character of the southern regions of Portugal in summer.

Some meteorologists have tried to establish a correlation between the sun spots, and between the phases of the moon, and the amount and distribution of rainfall.

10. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS BASED UPON HUMIDITY: ISOHYGROS, ISOHYETS AND ISONEPHS.

There is no term to indicate places having the same percentage of relative humidity. Such places may be joined by lines termed *isohygros*. Places having the same amount of rain are known as *isohyets*, and those with the same nebulosity as *isonephs*. The isohygros and the isonephs correspond closely with the isohyets, as may be seen from the comparison of the respective figures.

There is no scale for the classification of *evaporation*. The annual, winter and summer means of the 6 stations at which the evaporation is registered are, in round figures, 1600, 200 and 700^{mm}. Taking these figures as the bases the annual, winter and summer, evaporations may be termed excessive when they exceed the respective figures; moderate when they are between 1600—800, 200—100, and 700—350; and feeble when below 800, 100 and 350^{mm}, respectively, in a year, a winter and a summer. In general terms it may be said that the amount of evaporation is feeble in the N. Atlantic region, moderate in the Lusitanian and the

Mediterranean regions, and excessive in the S. Continental and the N. Continental.

According to their *relative humidity*, climates may be classified as very dry, when the amount is below 60 p. c.; dry, when it is from 60 to 70; moderately or feebly dry, 70 to 75; moderately or feebly moist, 75 to 80; moist, 80 to 90; and very moist, 90 to 100 p. c.

Upon this basis the characters of the five regions, in winter and in summer are:

N. Atlantic: moist; and moderately dry.

Lusitanian: dry; and very dry.

Mediterranean: moderately dry; and very dry.

N. Continental: moist; and very dry.

S. Continental: moderately moist; and very dry.

The *rainfall* may be classified as very scanty when its mean annual amount is below 150^{mm}; scanty when the amount is below 300^{mm}; very moderate, from 300 to 600; moderate, from 600 to 900; and excessive from 900 upwards. As regards the number of days, it is very rare when the number is below 50; rare, from 50 to 100; frequent, from 100 to 150, and very frequent from 150 upwards. In classifying the frequency of rain it would be more accurate to state the number of hours during which the rain falls in each month. On these bases the annual characters of the five regions are:

N. Atlantic: excessive; and very frequent.

Lusitanian: moderate; and frequent.

Mediterranean: very moderate; and rare.

N. Continental: moderate; and frequent.

S. Continental: moderate; and frequent.

In describing the seasonal characters the same terms may be used, taking as the basis one-half of the quantity of the annual fall and one-half of the annual number of

days of rain; thus, the rainfall is very scanty, in winter or in summer, when it is below 75^{mm}; scanty, from 75 to 150; very moderate, from 150 to 300; moderate from 300 to 450; and excessive when above 450^{mm}.

As regards *nebulosity*, it is frequent in the N. Atlantic region, extremely rare in the Mediterranean, and rare in all the other regions.

Portugal has had a notoriety for heavy rainfall for which there is no foundation in facts. Balbi stated in 1822, under express reservation, that Coimbra had in 1817 a rainfall of 80 inches (2032^{mm}) in October, and 108 inches (2743^{mm}) in November (1). Kämtz quoted Balbi in his *Lehrbuch der Meteorologie* (1831-1836), but stated plainly that he did not believe it to be a fact. Berghaus inserted the statement in his *Allgemeine Länder- und Völkerkunde* (1837–1846), but omitted, unfortunately, Kämtz's caveat. And Lombard accepted Berghans's statement in his *Traité de Climatologie médicale* (1877-1880). From these last two standard works the erroneous information crept into one of the earlier editions of Brockhaus's *Conversations Lexikon* (1883, article «Coimbra»); and filtered into popular guide books. One of these, published in London, leaving Coimbra aside, asserted cathegorically, in 1905, that «Portugal is a very wet country», and would have continued to do so up to this day if the editor's attention had not been drawn to his mistake. And all this notoriety is due to the simple fact that a newspaper at Coimbra had forgotten to place two decimal points in its meteorological report. In justice to Berghaus, one of the greatest authorities on geography and climatology, it is necessary to mention that in another volume of his book he describes the climate of Portugal as «one of the

healthiest and loveliest» of the world; and it is not difficult to detect the influence of his opinion in the writings of his successors.

Kohl considers the «Portuguese littoral as the most rainy region of the whole of the Iberian Peninsula» (2). This is also not quite accurate. The Portuguese littoral has not the same amount of rain as that of Gallicia, and as that of the Spanish portion of the Pyrenean region. The three southern regions of Portugal have less rainfall than the regions bordering on the Gulf of Genoa, and those bordering on the western coast of the British Isles (3). The mean rainfall in the Mediterranean region of France and Italy is $759^{mm}.4$; whereas the mean of Portugal is 750^{mm}.

Supan places Portugal in his hyetal region of moderate rainfall, and divides the country into two parts: that lying above the lat. 40°, with a rainfall both in winter and in summer; and that lying below 40°, with a rainfall only in winter (4).

II. EFFECTS OF VARYING DEGREES AND FORMS OF HUMIDITY UPON MAN.

The *evaporating* power of the air has a decided influence upon health. Normally there is in 24 hours an exhalation of about $900^{gm.}$ of watery vapour from the skin and from the lungs. Other conditions being equal, there is about double the quantity of moisture exhaled from the skin in a very dry day as compared with a very moist one. When the air is damp, there is a decrease in the evaporation of the skin and of the lungs, and an increase in the amount of urine and of the secretions of the digestive organs; and when the

air is dry, there is an increase in the evaporation of the skin and of the lungs, and a decrease in the amount of urine and of internal secretions; in one case there is a tendency to diseases of the kidneys and of the digestive organs, and in the other to those of the lungs and of the skin. The amount of evaporation determines the need of the quantity of water required for drinking purposes. Other circumstances being the same, the condition of the skin as regards evaporation determines the sensation of the intensity of dryness or moisture, and of the degree of heat.

When the absolute *humidity* falls to about $5^{gm.}$ there is a tendency to acute affections of the respiratory organs; and when it rises to $12^{gm.}$, to acute intestinal complaints.

Sudden and great oscillations in relative humidity are liable to give rise to various complaints. Damp air with increased pressure gives rise to a decrease in the number of pulsations, increased elimination of carbonic acid, nervous depression and quiet sleep. Dry air with a decreased pressure produces a quick pulse, dryness of the skin, nervous excitement and sleeplessness. A cold moisture with a strong wind increases the sensation of cold, a hot moisture with a strong wind decreases the sensation of heat. Given the same temperature, the air charged with much moisture becomes oppressive, while dry air is not so. A temperature of 45° is supported without great inconvenience when the air is dry, whereas a temperature of 30° to 35° becomes unbearable if very moist. These differences are noticeable on the coast when the wind blows from the north-east and from the south-west in winter.

A high relative humidity is relaxing, a low humidity

is stimulating, and frequent and sudden changes are dangerous. Cold humidity favours rheumatism and broncho-pneumonia; hot humidity gives rise to cutaneous diseases and intestinal complaints, and has a depressing effect both upon the body and the mind. The most suitable humidity to a healthy person is dry or moderately dry, combined with a cold temperature.

Rain may be beneficial or injurious according to circumstances. Showers of rain cleanse the air of impurities, allay dust, and reduce the temperature in summer; they are accompanied by a rise in temperature, and by a decrease in relative humidity in winter. Continuous rainfall during the day is depressing to invalids; it prevents them from getting out. Rainfall during the night prevents nocturnal radiations, and acts as a sedative, producing sound sleep. After heavy rain in winter, when the wind continues to blow from the S.W., there is more dampness in the air, and with a strong sun, the air has a depressing effect.

The amount of rain and its distribution have a considerable influence upon the prevalence of malaria and many other diseases.

Excessive *nebulosity* is depressing both to mind and body. Frequent mists are injurious to health especially in overcrowded places, for they prevent the beneficial effects of insolation. A misty atmosphere is capable of holding in suspension a large number of bacteria. Gouty, hypochondriacal and hysterical patients become worse when there are frequent and prolonged mists. Fogs are more depressing than mists. Clouds have, likewise, a psychical influence upon persons of nervous temperament and upon invalids in general.

A good fall of *snow* has the effect of purifying the

atmosphere of some of its impurities, such as dust, ammonia and nitric acid. People in the north say:

Ano nevoso,
Ano formoso

or

A snowy year
A beautiful year.

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CHAPTER VI.

TEMPERATURE.

> *Savitar* (Sun) *is the Lord of the whole world's life.*
> *It is he who controls what moveth not and what moves.*
>
> VÎMADEVA, in *Rigveda,* B. iv, h. 53, l. 2 and 6.

I. IMPORTANCE OF TEMPERATURE: SOLAR OR ASTRONOMICAL, NATURAL OR MEDICAL, AND METEOROLOGICAL TEMPERATURES.

A solar ray consists mainly of three energies: the thermal or caloric, the luminous or optical, and the chemical or actinic. This chapter will be devoted to the description of the thermal energy only.

The temperature forms the most important physical character of the air. Most people, when they speak of the climate of a place, mean its temperature. Life is impossible without a certain amount of heat. The daily, seasonal and annual temperatures depend upon the diurnal rotation of the earth upon its own axis, and upon the annual rotation round the sun, describing in its course an ellipsis. The absolute amount of heat received at any place, or in any latitude, is the same, being a little more in winter than in summer. This constitutes the *solar* or the *astronomical* temperature.

But the actual amount of heat that reaches the ground depends upon the atmospheric humidity, which in its turn depends upon the winds and upon the geographical features. This constitutes the *natural* or the *medical* temperature. The atmospheric temperature as observed at the meteorological stations, or the *meteorological* temperature, differs very considerably from the natural or the medical. In the former case, all precautions are taken to prevent the heat from the direct rays of the sun reaching the termometre, and to shelter the instrument from the heat resulting from the radiation of the surface of ground or water and from that resulting from the contact of the air with the ground or water; in the latter, or in the case of medical temperature, it is necessary to take into account all these influences, for a person living in the open air is subject more or less to all of them.

The observation of the medical temperature presents many practical difficulties, so that the meteorological temperatures form the bases of the description of medical climates. The medical temperature of a place can be roughly estimated at its proper value by studying not only the meteorological temperatures but also the geographical and topographical features, and the humidity and winds. The sensation of heat or cold depends greatly upon these factors, more so than upon the temperature alone. The terms cold, warm or hot have two senses: one objective, and the other subjective. A certain degree of temperature may, objectively or as it is registered in a thermometer, be warm; but, subjectively or as it is felt by an individual, be cold.

There is no uniformity in the meaning of the terms

used to describe the objective temperatures. The same words are used in different senses, which creates some confusion. The meaning of the terms used in the following pages will be defined in each case.

2. MEANS OF TEMPERATURE: YEARLY FLUCTUATION.

The *mean annual* and *seasonal* temperatures for 10 years, calculated from three observations a day, at the five stations are:

	An.	Wt.	Spr.	Sm.	Aut.
Oporto.....	14°.32	9°.08	13°.60	19°.59	14°.96
Lisbon......	15°.91	10°.78	14°.98	21°.01	16°.89
Lagos..... .	17°.21	12°.38	16°.20	22°.09	18°.19
Moncorvo...	15°.29	6°.69	14°.41	24°.31	15°.75
Beja........	15°.78	9°.53	14°.39	22°.54	16°.66

The means of the other stations, grouped under each climatic region, are:

	An.	Wt.	Sp.	Sm.	Aut.
I. Montalegre...	9°.91	4°.01	9°.35	16°.86	10°.40
Coimbra.....	14°.85	9°.83	13°.82	19°.81	15°.95
II. Guarda......	10°.79	4°.25	9°.22	18°.57	11°.12
Estrela	8°.81	2°.25	7°.02	16°.88	9°.45
San Fiel.....	15°.56	8°.10	14°.36	23°.61	15°.81
III. Faro.........	17°.65	12°.37	16°.24	22°.87	19°.12
V. Campo Maior	16°.03	8°.67	14°.71	23°.99	16°.75
Vila Fernando	15°.95	8°.37	14°.46	24°.29	16°.96
Evora.... ..	17°.61	9°.65	11°.53	22°.42	17°.34

The means of annual temperatures are not of much medical importance, for a mean of 15° may be made up of 25° maxima and 5° minima, as well as of 18° maxima and 12° minima. The seasonal means are of much more importance, and specially those of winter and of summer, for spring and autumn partake the characters partly of the cold and partly of the warm seasons.

In winter, Oporto is warmer than Moncorvo by 2°.39, and Lisbon than Beja by 1°.25. In summer, Oporto is cooler than Moncorvo by 4°.72, and Lisbon than Beja by 1°.53. Oporto, Lisbon, and Lagos present, more or less, the same differences in winter as in summer.

Coimbra, Beja and Evora have similar temperatures in winter, but in summer Coimbra is cooler by more than 2°.50. The coldest of all the stations is Estrela, and the warmest is Faro, but in summer the means of Faro and of Lagos are lower than those of Vila Fernando, Campo Maior and San Fiel.

The *yearly fluctuation* is the difference in temperature between the coldest and the hottest month of the year. The means of the coldest and the hottest months at the five stations, and their differences are:

Oporto: January 8°.44, July 20°.76; dif. 12°.32.
Lisbon: January 10°.09, August 21°.96; dif. 11°.87.
Lagos: January 11°.92: August 23°.94; dif. 12°.02.
Moncorvo: January 5°.67, July 25°.95; dif. 20°.28.
Beja: January 8°.72, July 23°.89; dif. 15°.11.

Lisbon presents the lowest fluctuation, and Moncorvo the highest, whereas Oporto and Lagos are

almost alike. January is the coldest month at all the stations, August the hottest at Lisbon and at Lagos, and July the hottest at the remaining three stations. At almost all the stations there are greater differences between the temperatures of March and April, and between those of September and October, than between those of any two successive months.

The fluctuation at the other stations are: Montalegre 15°.07, Coimbra 11°.58, Guarda 16°,90, Estrela 16°.45, San Fiel 18°.18, Faro 12°.73, Campo Maior 17°.57, Vila Fernando 19°.45, and Evora 14°.96. At Estrela the mean in December is 4°.32, in January 1°.11, February, 1°.3, March 1°.65, April 7°.85, and August 17°.57, which is the maximum.

It is easy to calculate from the tables given above the *seasonal fluctuations*, or the differences between the mean temperatures in summer and in winter at all the stations. At the five stations they are: Oporto 10°.5, Lisbon 9°.23, Lagos 9°.65, Moncorvo 17°.62 and Beja 13°.01. At the remaining stations they are: Montalegre 16°.85, Coimbra 9°.98, Guarda 14°.32, Estrela 14°.63, San Fiel 15°.51, Faro 10°.50, Campo Maior 15°.43, Vila Fernando 15°.82, and Evora 12°.77.

Faking all the stations as the basis, the yearly fluctuation of the whole country is 15°.32.

The mean temperature of Portugal as a whole may be estimated to be between 16° and 17° degrees, the mean in winter being 12°.5 and in summer 21°.

3. MEANS OF MAXIMA AND MINIMA: DIURNAL RANGE.

The means of *maxima* and of *minima* temperatures at the five stations, during 10 years, are:

1896-1905		An.	Wt.	Spr.	Sm.	Aut.
Oporto	max.	18°.26	13°.17	17°.43	23°.39	17°.43
	min.	10°.72	5°.86	9°.90	15°.72	11°.44
Lisbon	max.	19°.70	13°.76	18°.83	25°.73	28°.18
	min.	12°.90	8°.39	11°.85	17°.32	14°.04
Lagos	max.	22°.41	16°.89	21°.15	28°.18	23°.45
	min.	12°.21	8°.36	11°.21	16°.46	12°.84
Moncorvo	max.	17°.68	8°.36	16°.93	27°.34	18°.04
	min.	12°.90	4°.95	11°.88	16°.46	12°.84
Beja	max.	21°.19	13°.40	19°.67	30°.01	21°.66
	min.	10°.97	6°.16	9°.63	15°.63	12°.46

The means of maxima and minima, in winter, at Montalegre are 7°.96 and —0°.52; Guarda 6°.96 and 1°.34; and Campo Maior 13°.86 and 4°.61; whereas in summer the respective figures are: 23°.58 and 10°.34; 23°.58 and 13°.35; and 27°.34 and 16°.01.

The terms *diurnal range* are used to denote the difference between the mean minima and the mean maxima of a month. They may, in a similar way, be used to denote the same differences in a year or in a season. It would be preferable to use the simple words «range», «amplitude», or «oscillation», to designate these differences, instead of «diurnal range»,

for the terms «annual diurnal range», «seasonal diurnal range», «monthly diurnal range» and «daily diurnal range» are rather incongruous.

The *annual* diurnal ranges of temperature or differences between the maxima and the minima, at the five stations are: Oporto, 7°.54, Lisbon, 6°.80, Lagos, 10°20, Moncorvo 5°,78, and Beja 10°.22. These figures, like the annual mean temperatures, are not of much importance.

The *seasonal* diurnal ranges of temperature or the differences between the maxima and the minima, in winter, are: Oporto 7°.30, Lisbon 5°.37, Lagos 8°.53, Moncorvo 3°.41, and Beja 7°.24. Lisbon presents less variation than Oporto and Lagos, Moncorvo presents the lowest, and Beja less than Lagos. In summer the ranges at the five station are: 7°.66, 8°.41, 11°.72, 6°.05, and 14°.35, respectively.

The *diurnal* ranges, as usually understood, or the differences between the mean maxima and the mean minima in each *month*, present the following peculiarities. Oporto shows almost a uniform range, the minimum being 6°.73 in December, and the maximum 7°.97 in August. At Lisbon the range is lower than at Oporto in the months during winter, the minimum being 4°.99 in December; but it is higher in summer, the maximum being 8°.58 in August. At Lagos the mininum 8°.70 is in December, and the maximum 13°.63 in August. Moncorvo shows 3°.35 in December and 6°.31 in July; and Beja 6°.78 in December, and 15°.08 in August. The monthly ranges at Coimbra are lower than at Beja. Coimbra has a similarity with Oporto, and Guarda with Lisbon. The ranges are much lower at Guarda than at Montalegre.

The *daily* diurnal ranges or the differences between the mean maxima and the mean minima in 24 hours are less in winter than in summer. At Lisbon the range between the 6 maxima and the 6 minima is 2°.88 in January and 4°.25 in July.

The diurnal ranges of temperature are of great medical importance; they are higher in the medical than in the meteorological temperatures.

4. MEANS OF EXTREME MAXIMA AND EXTREME MINIMA: EXTREME RANGES.

The means of the *extreme maxima* and *extreme minima* at the 5 stations are:

1896-1905	Extreme	An.	Wt.	Spr.	Sm.	Aut.
Oporto	max.	26°.4	17°.1	24°.8	31°.0	24°.2
	min.	5°.9	0°.6	4°.7	11° 5	6°.3
Lisbon	max.	25°.6	17°.0	26°.2	33°.5	25°.8
	min.	9°.2	3°.9	8°.4	14°.4	10°.3
Lagos	max.	27°.8	20°.3	27°.7	34°.9	28°.6
	min.	2°.4	2° 6	5°.5	12°.9	8°.4
Moncorvo	max.	22°.3	12°.2	22°.1	32°.1	22°.6
	min.	9°.0	1°.6	7°.9	17°.2	9°.3
Beja	max.	27°.3	16°.9	27°.6	37°.2	27°.4
	min.	6°.7	1°.7	4°.9	11°.2	7°.5

This table presents the interesting fact that the mean annual extreme maxima are lower at Lisbon than at

Oporto and Lagos, whereas the extreme minima are much higher. In summer the means of the extreme maxima at Lisbon and Oporto are alike, but in winter they are six times higher at the former city; in fact there is no other station in which they are higher. In spring and in autumn Lisbon has a considerable advantage over Oporto and Lagos as regards the means of the extreme minima.

The *extreme ranges* are the differences in the means of the extreme maxima and extreme minima in a year, a season, a month or a day. In winter the extreme range at the 5 stations is: 16°.5, 13°.1, 19°.7, 11°.6 and 15°.2, or Lisbon stands midway between Oporto and Lagos. In spring the range is higher at Lisbon than at Oporto or Lagos, whereas in summer and autumn there is a greater similarity between Lisbon and Lagos, than between both those stations and Oporto; or in other words, at both the former stations there is comparatively a greater rise in summer and autumn than in winter.

5. ABSOLUTE MAXIMA AND ABSOLUTE MINIMA: ABSOLUTE RANGE.

The *absolute temperatures* have not the same interest in medicine as in agriculture, for a very low tomperature, even for a short period, is very injurious to 'some plants. The absolute maxima during 1896-1905 are the same at Lisbon and at Lagos, 37°.8, whereas it is lower by 1°.2 at Oporto. The maxima at Moncorvo is 37°.4 and at Beja 40°.4. As regards absolute minima. Oporto and Lagos are alike, — 1°.8, Lisbon has + 0.5, Moncorvo — 3.5 and Beja — 3.6.

The *absolute range* in winter is nearly equal between Oporto and Lisbon, but it is much higher in spring than in summer and autumn; whereas Lagos, compared with Lisbon, presents a higher absolute range in winter, almost equal in summer, and lower in autumn and spring.

The absolute extremes and the mean of extreme temperatures do not occur exactly at the winter and summer solstices but somewhat later, which is due to the fact that the temperature of the surface of the earth lost during the night depends upon the length of the night. In summer the nights being short, a certain amount of heat goes on accumulating, and shows its effect after the solstice; and, conversely, the cold shows its effect after the winter solstice. For similar reasons the hottest time of the day is about the 14th hour, and the coldest before sunrise.

6. INFLUENCE OF GEOGRAPHICAL FEATURES UPON TEMPERATURE.

Before describing the influence of the geographical and topographical features of Portugal upon the march of temperature in different regions, it is of great interest to notice two important facts. The first is: the *mean temperature of the earth* has been calculated at 15° (1). Portugal is the only country in Europe which has a coast, with an Atlantic marine climate, the mean annual temperature of which corresponds with the mean annual of the earth. And this climate is represented by Lisbon and, in a general way, by the coast of the Lusitanian region. And the second is: in 40° N. lat., on the Portuguese coast, the *mean temperatures of land and*

of the surface of the sea water is the same. In higher latitudes the mean temperature of the sea is higher than that of the land; and in lower latitudes it is just the reverse. These differences have an important bearing on the Portuguese climate. The parallel of 40° marks the natural line of division, along the coast, between the N. Atlantic and the Lusitanian regions.

The most important factor in the determination of the temperature of a country is, other conditions being the same, the *latitude*. All conditions being equal, the natural or medical temperature in the latitude of 45° would be the mean between the equator and the poles; but such is not the case. Owing to the irregular distribution of land and water, and to the atmospheric and oceanic currents, the mean annual temperature in 45° N. lat. is not the same as in 45° S. lat., and the temperature along the parallel 45° or any other parallel is not the same for any long distance, even in a comparatively small country such as Portugal.

Oporto in a slightly lower latitude and at a lower altitude by 315 m. than Moncorvo, presents a lower temperature by 0°.97; and Lisbon in a lower latitude and in a lower altitude by 193 m. than Campo Maior has a lower temperature by 0°.12. Between 30° and 45° N. lat., the mean annual temperature decreases at the rate of 1° per 185 km. The greatest length of Portugal being 572 km., the difference in temperature between one end and the other, would be, other conditions being equal, 3°.09. The difference of temperature between Oporto and Lisbon is 1°.59 and between Lisbon and Lagos 1°.3, or in other words, the climatic regions represented by the three stations stand, judged by their temperature, nearly in relation of their

respective latitudes without taking into account the altitudes. Moncorvo and Beja show a difference of only $0^{\circ}.49$.

The fluctuations and ranges of temperature depend, other circumstances being the same, upon the amount of heat received from the sun during 24 hours; and so they vary according to latitudes and seasons. In the latitude of Portugal, the range at Oporto, Lisbon, Lagos, Moncorvo and Beja is greater in summer than in winter by $0^{\circ}.36$, $3^{\circ}.04$, $3^{\circ}.19$, $2^{\circ}.54$, and $7^{\circ}.13$, respectively.

The varying *altitudes* form one of the important elements which give rise to variation of temperature. In the latitudes of Portugal, there is a decrease of 1° of temperature for every 180 m. of altitude of mountains, or $0^{\circ}.55$ for every 100 m. In winter this decrease is 1° per 200 m., and in summer 1° in 160 m. In the free air, as noticed in the ascent of balloons, the decrease is $0^{\circ}.6$ to $0^{\circ}.7$ for every 100 m., the difference between this temperature and that of mountains being due to the radiation of heat from the soil. One of the causes of the decrease of temperature in ascending a mountain is the rarefaction of the air, which determines the heat absorbing power.

The mean temperature on mountains depends, especially in winter and in summer, not only upon their heights but also upon their exposure. The surface with the south-western aspect has the highest temperature in winter, whereas that with a northern, or north-eastern, aspect has the lowest in summer. These differences are noticeable in the temperatures registered at Montalegre, Estrela and Guarda. The mountains modify the temperatures of the surrounding plains, by sheltering or exposing them to favourable or unfavour-

able influences. In winter the mean temperature is higher up to a certain height above the valleys. This explains why many of the towns and villages are built on the sides of mountains or hills. The mean difference in temperature between Figueira da Foz (10 m.) and Estrela (1386 m.) is between 10° and 11°.

The yearly fluctuation decreases with increasing elevation: it is 18°.18 at San Fiel (516 m.); 17°.71 at Guarda (1.039 m.); and 16°.45 at Estrela (1.386 m.).

The ranges of temperature are also less on mountains than on plains. The annual diurnal range at Montalegre (1027 m.) is 10°.52, and at Guarda (1.039 m.) 7°.62; whereas at Campo Maior (288 m.) it is 12°.17; and at Beja (284 m.) 10°.22.

But in the matter of fluctuations and ranges a great deal depends upon the amount of humidity in the air, the frequency of mists and clouds, and the velocity of winds. These factors explain the lower range at Guarda as compared with Montalegre, and the lower range at Beja as compared with Campo Maior.

The differences in temperature in sun and shade are greater in high altitudes than in plains, for the solar radiation is stronger in the former than in the latter. In summer it is sufficient to be in the shade in altitudes to feel cold.

There are some differences in the temperature of a tableland or plateau as compared with a lowland. Given the same latitude, there is not in Portugal much difference in the annual means, but the fluctuations and ranges are greater in the former than in the latter.

The temperature of the *soil* and terrestrial radiation are important elements in medical temperatures. The mean temperature of the soil in Lisbon, at a depth of

5 c. m., is 15°.1; at 1°.50 m., 17°.0; and at 10 m., 17°.6. It is uniform from 10 to 20 m., but afterwards it increases at the rate of 1° per 30 m. of depth.

The soil influences the temperature in the lower strata of the air by its colour, its polish and consistency, and its dampness or dryness.

A white soil has a greater radiating power than the black, or the heat radiating power is in an inverse ratio to the heat absorbing power. Snow stands first in its radiating power, then follow white soil, and grey soil. The white sandy soils of Portugal occupy an area of about 60,000 hectars. Colour has no influence in the radiation of heat during night.

A loose and dry soil, like sand, conducts heat slowly, whereas compact soils, like clay, conduct it more easily. A solid and shining rock radiates more heat than loam and clay; and a loose soil more than one covered with vegetation. The influence of rocky formations, combined with the configuration of mountains, is well exemplified by the narrow portions of the valley of the Douro in which are situated Régoa and Lamego. This valley runs from east to west, and is consequently exposed to the sun during the whole day; and the sides of hills and mountains are covered with rocky slates; so that the radiation of heat from the valley itself, and the reverberation of heat from the rocky slopes give rise to such an intense temperature in summer that it is known as the «hot region» of the Douro.

Compared with the sea, the same amount of heat will raise, during the same time, the temperature of land in the proportion of 5 to 3 of the sea; but land loses it much more rapidly than water. For these reasons the temperature of inland places gets very warm

during the day and during summer, and cold during the night and during winter.

The air in contact with a dry soil has a higher temperature than that in contact with a damp soil. There is a greater range of temperature in the strata of air in contact with the ground than in the air in the higher strata, for the air in the lower strata gets more heated both by contact and by radiation. This explains how in a limited area there are often a great variety of temperatures near the ground.

The *sea* is a great reservoir of heat. As compared with land, water takes a longer time to absorb the same amount of heat, but it retains it much longer; also the solar heat penetrates down to 200 m. on the sea and only to about 1 m. on land. The temperature of the surface of the sea is much more constant and equable than that of land, and the sea reflects heat much better than land. When the water on the surface of the sea gets cool, it sinks and is replaced by hot water below; there is no similar convection on land.

The mean annual surface temperature of the Lusitanian Sea is about 17°.0, and the mean in winter is between 16°.5 and 15°; in spring 15° and 14°.5; in summer 30° and 18°; and in autumn 20°.5 and 18°.5. According to Buchan, the diurnal fluctuation is only 0°.44 (0.8 Fahr.), and «the daily range of the temperature of the air as compared with that of the sea (Atlantic), is from three to four times greater than that of the surface temperature over which it lies» (2).

The Gulf Stream has a great influence upon the mean temperature of the Lusitanian Sea. In the Mid-Atlantic the difference between the water of the Stream and of the ocean not affected by the stream is 10° to 15°.

The difference in the two waters along the western coast of Europe varies between 2° and 5°. If there were no Gulf Stream there would be no warm temperate regions in Portugal. The sudden changes of the Stream further north or further south have a great influence in the winter climate along the western coast of Portugal.

The influence of the sea on the temperature on land varies, other conditions being the same, according to the distance from the coast. The sea does not reduce the mean annual temperature on the coast, but it increases the mean in winter and decreases the mean in summer or reduces the seasonal fluctuations. Oporto has a mean annual of 14°.32, and Moncorvo, situated 170 km. inland, has 15°.29, but the means in winter and in summer in the former are 9°.08 and 19°.15, and in the latter 6°.69 and 24°.31; in the same manner Lisbon has a mean annual of 15°.91, and Beja 75 km. inland has 15°.78, but in winter and in summer the former has 10°.78 and 21°.01 and the latter 9°.53 and 22°.24. Campo Maior, which is the furthest station from the coast, 160 km., presents a mean annual of 16°.03 with a mean of 8°.67 in winter and a mean of 23°.99 in summer. These differences become still more noticeable when Lisbon is compared with Madrid. In January the mean at Lisbon is 10°.43 and in July 20°.72; at Madrid the respective figures are 4°.6 and 25°.1. It is for this reason that it is of importance to know the distance of a meteorological station from the sea (Ch. II. 9).

The diurnal ranges increase in proceeding inland. The range at Campo Maior is nearly double that of Lisbon. Some localities, as Moncorvo, owing to their special topographical conditions, form an exception.

An important element in the modification of the temperature on the coast is the reflection of the solar heat from the surface of the water. In estimating the amount of heat from this source, the configuration of the place as well as the degree of the declination of the sun have to be taken into account, for the maximum declination is attended by the maximum of reflection. It has been shown that at some places the reflected heat in the afternoon, under favourable circumstances, is 44 p. c. higher than the direct temperature of the sun. This is the reason why mornings and evenings are warmer on the coast than inland.

Owing to the great uniformity of the surface temperature of the sea, the differences in temperature between sun and shade are less on the coast than in high altitudes.

The influence of the rivers upon temperature is quite local. It depends upon the direction of winds and upon evaporation. As the temperature of the water is low in winter, the rivers do not raise the temperature on the neighbouring land in winter.

The influence of *vegetation* upon temperature depends upon whether the vegetation consists of forests or of meadows. Large forests moderate the extremes of temperature in the continental regions in the same way, although not to the same extent, as the ocean in the marine regions. When a forest is situated near the sea, the minima are lower in the forest than on the coast. Souza Pimentel has shown that the maxima at San Pedro de Muel, in the open sea-shore is $18^{\circ}.1$; as compared with $18^{\circ}.7$ in the forest, $4^{\mathrm{km.}}7$ inland, whereas the minima at the two places are $10^{\circ}.5$ and $8^{\circ}.3$ respectively, or $2^{\circ}.2$ less in the forest (3).

In forests the mean annual temperature is lower than that of meadows, and still lower than that of a bare country. The difference, on the whole, does not exceed perhaps $0^{\circ}.5$ to 1°. It is greater in summer than in winter. Forests prevent the insolation of the soil; and give rise to more evaporation from the leaves. The range of temperature is likewise less in a forest than in the open country. The soil temperature in a forest is cooler than that of a desert, the mean annual difference may amount to 10°, the difference being naturally greater in summer than in winter. Forests render the days cooler and the nights warmer. Deforestation increases the extremes of temperature both of the air and of the soil.

When the heat is due to sun, vegetation cools it; but when there is a cold wind, vegetation, especially of pines, acts as a shelter.

A meadow is cooler than the bare soil. Weber has found the differences in temperature of the air in contact with grass and in contact with sand to be as high as 18° to 21° (4). The radiation in a meadow is very low, and the temperature is more equable.

Considering the whole country, vegetation has a greater influence in the temperature of the N. Atlantic, Lusitanian and Mediterranean regions than in the N. and S. Continental regions.

Most of the cities and villages of Portugal as already stated (Ch. II. 7), are situated on elevations with a southern aspect; and all the important towns and villages along the western coast are placed on the right banks of rivers, that is, also with a southern aspect. Such localities afford a better protection against excessive cold. The temperature in a large city like Lisbon

depends greatly upon the topography and exposure of its various parts. In some parts of Paris the mean temperature is higher by 0°.8 than that in the open country. The differences in medical or natural temperatures are still higher; according to exposure they vary from 1.°5 to 4° in the open country, and from 5° to 10° in a city.

7. WINDS AS CONTROLLERS OF TEMPERATURE.

The winds control greatly the distribution of temperature. A change in the winds brings in a change in temperature. The following table shows the temperatures, in January and in July, corresponding with some of the most prevalent winds at Lisbon and Coimbra.

	Lisbon		Coimbra	
	Jan.	July	Jan.	July
N.	10.°22	21.°94	—	—
N. N. E.	9.°22	23.°30	—	—
N. E.	9.°43	25.°87	—	—
E. N. E.	9.°83	—	7.°93	—
E.	10.°74	—	—	—
E. S. E.	11.°25	—	—	—
S. E.	—	—	—	—
S. S. E.	12.°08	—	7.°61	—
S.	11.°97	—	8.°46	—
S. S. W.	12.°52	19.°70	11.°22	—
S. W.	11.°82	21.°18	—	—
W. S. W.	11.°98	21.°51	—	—
W.	10.°56	19.°98	—	—
W. N. W.	10.°94	20.°18	—	20.°58
N. W.	10.°60	20.°66	8.°07	19.°65
N. N. W.	10.°40	21.°26	7.°13	18.°46

Broadly, speaking the southern or the equatorial winds are warmer than the northern or the polar, but a great deal depends upon the seasons and upon the temperature of the country, or of the sea, over which they have travelled.

The temperatures of winds in winter are usually opposite to those from the same or nearly the same quarter in summer. At Lisbon, in January, the lowest temperature corresponds with N.N.E., and the highest with S.S.W.; whereas, in July, the lowest corresponds with S.S.W. and the highest with N.E. In winter the sea is warmer than the land by about 6°, whereas in summer it is cooler by about 4°. The reverse is the case with the temperature of the land. In winter the winds proceeding from N.N.E. have traversed regions covered with snow; and in summer over regions with a very high temperature. As both the very hot and the very cold winds proceed usually from Spain, there is a saying in Portuguese: «*De Espanha nem bom vento, nem bom casamento;* or, «from Spain there is neither good wind nor a good marriage». The Spaniards, unable to say anything in disparagement of the Portuguese winds, retort: *Los portugueses son pocos y locos,* or «the Portuguese are few and foolish».

The seasonal winds modify greatly the temperature of the various regions of Portugal. There is, for instance, a greater seasonal range in winter at Oporto than at Lisbon, for the winds both from the sea and from the land present a greater difference in temperature than the corresponding winds at Lisbon. In summer it is just the reverse; owing to greater differences in the temperatures of the land and the sea winds, there is a greater range of temperature at Lisbon than at

Oporto. In estimating the mean temperatures corresponding with each wind, their frequency and duration have to be taken into account.

The fact, already noticed, that above 40° N. lat. the temperature of the sea is higher than that of the land, and that below it that of the land is higher than that of the sea, has an important bearing upon the winds. Other conditions being equal, the winds from the sea in the parallels higher than 40° have, comparatively speaking, a higher temperature than the land winds, whereas the reverse is the case in the parallels below 40°. But it is needless to say that a great deal depends upon the seasons and other circumstances.

As winds blowing from the sea or from land frequently change their direction (Ch. IV. 5), it is necessary to note for each place the temperatures corresponding with each wind. The deflection of the Gulf Stream by a strong wind may bring to the surface a stratum of cold water, and lower the temperature when the wind changes its direction. This may be the reason why at times the west winds are cold in winter in the Lusitanian region. Sudden changes of winds give rise to sudden changes of temperatures.

The occasional or cyclonic winds give rise to extremes of temperature. A very occasional wind from the southern quarter is the African desert wind, which blows during 2 or 3 days at a time on the coast of Algarve, and gives rise to a very hot temperature. Its influence is felt, at times, up to the Serra of Cintra. Another occasional wind proceeding from the northeasterly direction gives rise to excessive cold in winter, and to the fall of snow even down to the Serras of Algarve. Both these winds are often absent during

the course of a season. When they occur they are more injurious to plants than to men. A distinction has to be made between the temperatures corresponding with the general or seasonal winds and those due to sea or mountain breezes, when both proceed from the same direction. In winter, for instance, on a warm day, the S.W. breezes at Mont'Estoril are cooler than the S.W. winds. In summer a mountain breeze is cool, but from the same direction there is sometimes a very hot wind. This shows that the mere direction of a wind as registered at a station is not always a sure guide to its temperature.

The influence of winds upon temperature depends greatly upon the amount of moisture they contain. In comparing the influence of winds upon humidity (Ch. v. 8), and the influence of winds upon temperature, it will be seen that there is a close correspondence between the two. The S.W. winds in winter, which are charged with a great deal of moisture, are much warmer than the N.E. winds, which are dry.

The same elevation of a hill or mountain does not afford equal shelter from all winds. In this respect the gradient or the inclination of the wind has to be taken into account. In Portugal a protection against the north winds requires often a much higher altitude than against the south winds. This is well exemplified by the Serra of Cintra, on the northern side of which one does not feel to the same extent the southerly winds, as one feels on the southern side the northerly winds.

The influence of the four cardinal winds may be thus summarised: the Southern are warm; the Northern are cold; the Western, moderately cold; and the Eastern very cold in winter and very hot in summer.

8. INFLUENCE OF HUMIDITY UPON TEMPERATURE.

When a watery vapour condenses into a liquid, or a liquid into a solid, it sets free heat; but when a solid turns into a liquid, or a liquid into a vapour, it absorbs heat.

If the moisture in the air be warm, rapid evaporation gives rise to a sensation of cold, which is often agreeable; but if the moisture be cold, rapid evaporation increases the sensation of cold.

The aqueous vapour in the air, although very small, has an important influence upon temperature. Tyndall in describing the influence of moisture upon temperature says that the solar rays are different in quality from the earth's rays, and that it does not follow that the aqueous vapour which absorbs the one must necessarily absorb the other. Through a layer of water 1/10th inch (2 mm. 54) in thickness, the sun's rays are transmitted with comparative freedom; but through a layer half this thickness no single ray from the warm earth could pass (1). He believes that probably from 10 to 15 p. c. of the heat radiated from the earth is absorbed within 10 feet (3 m.) of the earth's surface.

The air may be perfectly transparent to light, and yet be capable of absorbing a good deal of heat. Dry and pure air in diathermanous or transparent to heat. The specific heat of pure dry air is very low.

Other conditions being the same, the amount of aqueous vapour in the air determines the fluctuations and ranges of temperatures. In comparing the mean relative humidity with the mean temperature, it will be seen that there is a close correlation between the two.

A high relative humidity renders the temperature more constant and more equable. These differences are very noticeable in the fluctuations and ranges of temperature at Oporto, Lisbon and Beja.

Rainfall is attended by an increase of temperature. After a rainfall there is a decrease of temperature which is agreeable in summer but not in winter.

The sensation caused by mists varies according to seasons or according to temperatures. When the temperature is warm a mist may be agreeable. Cloudy days in the latitude of Portugal are warmer in winter and cooler in summer. When a large surface of ground, is covered with snow for some months, as in high altitudes, there is a greater calm and a more equable temperature.

9. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS BASED UPON TEMPERATURE: ISOTHERMS AND THERMIC ZONES.

Humboldt classifies climates, as regards *mean temperatures,* thus: torrid 27°-25°, hot 25°-20°, warm 20°-15°, temperate or cool 15°-10°, cold 10°-5°, very cold 5°-0°, and polar below 0°. The warm and the cold are also sometimes styled the sub-tropical and the sub-polar, respectively.

This classification is very good when applied to a large country or region, but it does not convey a very definite idea when applied to a health resort. Some writers have employed very loosely the word «temperate». One has gone so far as to describe a place with a temperature of 8° as very temperate. For the purposes of this book a uniform classification has been adopted, as follows:

10° — 12° = cool temperate,
12° — 14° = moderately cool temperate,
14° — 16° = most or very temperate,
16° — 18° = moderately warm temperate, and
18° — 20° = warm temperate.

The words «most» or «very» temperate is applied to temperatures bordering upon 15°, because this figure represents the mean temperature of the earth, and this temperature is, or ought to be, the most temperate. There is no doubt that it is the most agreeable to the great majority of people.

As regards *fluctuation,* the temperature is low or constant when the difference between the hottest and the coldest month, or between winter and summer, does not exceed 10°; moderate, when between 10° and 15°; high, between 15° and 20°; and excessive, when above 20°.

As regards *range*, the temperature is very equable, when below 5°; equable, between 5° and 10°; moderately equable, between 10°-15°; variable, between 15°-20°; and very variable, when upwards of 20°.

With respect to the *subjective sensations* due to temperature, scales have been framed for their description, but as one person's sensations are hardly similar to those of another, such observations are of no practical value. Each person can, and actually does, frame a scale for his own use, and so a climate may be intolerably, excessively, tolerably, or agreeably hot or cold; or it may be mild and fresh, mild and soft, cool and exhilarating, quite fresh, very fresh, &c.

As the belts of temperature based upon the parallels of latitude (Ch. II. 7) do not represent the mean temperatures in each belt, Humboldt was the first to divide each hemisphere into zones based upon *isothermic,*

isochimenic and *isotheric* temperatures, that is, lines showing the mean annual, the mean winter, and the mean summer temperatures reduced to the level of the sea (Maps III. and IV.). These lines are much more irregular on land than on the sea.

Supan has proposed to name a zone warm, when the mean annual temperature is above 20°; temperate, when the mean annual is below 20°; and cold, when the warmest month is 10° (1). Isothermic lines in high latitudes do not convey a good idea of the climate.

The isotherms of Portugal have been studied by Brito Capello (2), and those of the Iberian Peninsula by M. de Bort (3). They are not of much interest from the medical point of view, for they represent in a less degree the medical temperature of a place than the meteorological. The mean annual isotherm of the northern hemisphere along the western coast of Europe crosses the coast of the Lusitanian region.

The surface isotherms of the Lusitanian Sea are 16.3° in the north and 17.8° in the south, that is, in the northernmost and the southernmost latitudes of Portugal (4). Portugal is the only country in Europe which is under the influence of the *constantly temperate sea* temperature during the whole year.

Köppen has proposed another classification (5), based upon the cold, temperate, warm and hot temperatures during a certain number of months in a year. He divides each hemisphere into 7 *thermic zones:* 1) the polar; 2) the cold, with 1-4 temperate months; 3) the zone with a temperate winter; 4) the temperate zone with a warm summer; 5) the constantly temperate zone, or the mountains belonging to zones 3 and 4; 6) the subtropical zone with 4 to 11 warm months, and 7) the

tropical zone. He places the whole of Portugal in his 3rd, 4th, and 5th zones, or zones having at least 8 months in the year with a mean temperature below 20°. He places the country to the north of the latitude of Lisbon into his 3rd zone, and the country to the south in the 5th.

Taking the five typical stations as the bases, the five regions may be classified as regards their temperature as follows:

N. Atlantic: winter cold, summer warm; fluctuation moderate; range equable both in winter and in summer.

Lusitanian: winter temperate, summer hot; fluctuation moderate; range very equable in winter and equable in summer.

Mediterranean: winter temperate, summer hot; fluctuation moderate; range equable in winter and moderately equable in summer.

N. Continental: winter cold, summer hot; fluctuation excessive; range very equable in winter and equable in summer.

S. Continental: winter cold, summer hot; fluctuation moderate; range equable in winter and variable in summer.

If the size and extent of the territory be taken into account, Portugal presents a greater variety of seasonal temperate temperatures than Great Britain, France or Italy. This fact is well brought out by the examination of the isotherms and the thermic zones of Köppen.

A comparison of the yearly fluctuation of Lisbon with other places in the same latitude is instructive. Lisbon, according to Fischer (6), has a mean annual temperature of 15°.6 and a yearly fluctuation of 10°.9, whereas the respective figures for Murcia are 17°.0 and 16°.8; Palermo, 17°.6 and 14°.0; Patras 18°.0 and 17°.2;

and Athens, 18°.2 and 19°.4. Or, in other words, no place has such a low fluctuation as Lisbon. Oporto, too, has a lower fluctuation than Barcelona, Naples and Constantinople.

There is, likewise, no city or town in the same isotherm as Lisbon which has a lower fluctuation or a lower range of temperature. Marseilles, Genoa and Rome are, in these respects, all inferior to Lisbon.

In January the only portion of the Continent which has a mean temperature higher than 10° lies to the south of a line drawn from Lisbon, through Seville, to Malaga, and thence northwards along the coast to Alicante and Valencia. But although the mean in winter of some of the places such as Lagos, Faro, Cadiz, San Fernando, Tarifa and Malaga is somewhat higher, still not one of them has such a low range as Lisbon. This privileged condition of the coast of the Lusitanian region is due entirely to the nature of the prevalent winds and to the influence of the Gulf Stream.

10. EFFECTS OF VARIOUS DEGREES OF TEMPERATURE UPON MAN.

When a healthy person passes from a warm to a cold temperature, his surface temperature is reduced, and the nervous and muscular systems are stimulated; there is a contraction of the superficial blood-vessels, with a tendency to coldness of the extremities, accompanied by a stasis of blood in the internal organs. All these changes give rise to an increased demand for heat production; there is a decrease in transpiration with a corresponding increase in the amount of urine; an increased appetite; an inclination for muscular

exertion; a decrease in the number of pulsations and respiration; and a good repose of the brain, giving rise to sound sleep. If the cold be excessive, the extremities become cold and dark red, and there may be local gangrene; there may be pulmonary or cerebral congestion, followed by deep somnolence and death. If proper precautions be taken as regards food and clothing, the human body seems to be able to endure great cold, provided the air is calm.

When, on the other hand, a person passes from a temperate to a hot temperature, the physiological effects, with the exception of the pulse, are reversed. There is a relaxation of the superficial blood-vessels accompanied by profuse perspiration and followed often by prickly heat; a diminution in the arterial tension with an increase in the number of pulsations; and a decrease in respiration; a decrease in the amount of urine; loss of appetite especially for animal food; a disinclination for muscular and mental exercise; headache and disturbed sleep. If the heat be excessive, it may give rise to vesication of the skin, sudden syncope, or sunstroke.

And, lastly, on passing from a hot or from a very cold temperature to one that is temperate or to 15°, the physiological effects are more or less equally balanced; all the functions are more or less regular or normal. Such a temperature, which is the mean of the earth, is the most agreeable to the very great majority of people, and very suitable to many invalids, provided the yearly fluctuation and the diurnal range are favourable. In healthy persons, a moderate yearly fluctuation, with a variable diurnal range, is conducive to the healthy development of the body and mind; whereas in the case of invalids the temperature has to be constant and

equable. Persons brought up in temperate temperatures are able to support better the extremes of cold or of heat (Ch. x, 8), or, in other words, the physiological functions get more easily adjusted than in persons who pass from a very cold to a hot temperature or vice-versâ.

The temperature of the soil has a great influence upon the development of micro-organisms, and thus in determining the healthiness of a place.

The sensation caused by a moderate degree of temperature depends, first, upon the force of the winds, the amount of the atmospheric moisture, and the nature of the heat; and, secondly, upon the age, the constitution, the temperament, and the nature of the disease, if any.

A great degree of heat can be supported if the air be dry and the winds strong, whereas a great cold can be supported if the air be likewise dry, but if there be no winds. In the first case the evaporation is increased, in the second it is reduced to its minimum. When the relative humidity is very high, a decrease of a few degrees of temperature is at once noticeable, whereas the reverse is the case when it is low. Humboldt has described how a «change of not more than 7° or 8° gives rise to an excessive feeling of cold. On the coasts of the South Sea the ordinary temperature of the air is 28° C... In Cuamana after a heavy rainfall one hears people calling out in the streets, *How very cold it is! I am frozen!* And yet the thermometre exposed to the air registers 21.°5» (1). Where the air is charged with great moisture people feel more cold at the setting of the sun than when it is moderately dry. On the other hand, Dr. Onimus has pointed out how people feel very cold in winter on the French Riviera

at 17 o'clock, when the day is very clear and the air is dry (2). In the first case the sensation is due to conduction, in the second to radiation. The heat depending upon the direct rays of the sun is much more bearable than the same degree of heat arising from terrestrial radiation. With the same degree of temperature the sensation of cold in a house is sometimes greater in rooms exposed to the south than in those exposed to the north.

In connection with this subject it may be mentioned that there is a widespread belief, even among many medical men, that people born and bred in a hot or warm country are able to bear heat better than those born and bred in a cool or cold country. This is, generally speaking, a mistake. All rules in physiological processes have their exception, but it is a fact that people born in a warm country are not better adapted to bear more heat. Their nervous system, owing to the heat, becomes weakened, and any additional heat puts a great strain upon them. On the other hand, people of cold climate, owing to the strength of their nerves, are capable of bearing, proportionately, a higher degree of heat.

A healthy young person bears great cold better than the old and the aged. The sanguine and the irritable do well in a cold climate, and the lymphatic and the depressed, in a warm. The neurasthenic do well at times in a cold and at times in a warm temperature.

Sudden and excessive changes of temperature are injurious to all, but especially to the invalid. A change from a great heat to a great cold is liable to give rise to disease of the kidneys and respiratory organs; and a change from great cold to a great heat to diseases

of the liver and the alimentary canal. If proper precautions be not taken as regards food, dress, drink, and other habits, a permanent or prolonged change from one place to another is likely to affect injuriously if the difference in the temperature of the two places be more than 11° or 12°.

A high temperature due to the direct rays of the sun can be avoided by remaining indoors, but when the high temperature is due to hot winds, it is not so easy to avoid it.

The temperature of the soil, combined with the level of the subsoil water, has an influence upon the prevalence of typhoid fever, diarrhœa and some other diseases.

All conditions being equal, a cold temperature in a healthy person is stimulating, a warm is relaxing, a temperate is sedative and tonic, and the extremes are depressing. An equable temperature is sedative, and a variable is stimulating. To the weak and the convalescent a warm or even a hot temperature may be stimulating. The very equable makes the least demand upon the heat producing organs.

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CHAPTER VII.

SUNLIGHT AND ELECTRICITY.

Sol est remediorum maximum.
PLINIUS: *Nat. Hist.* Lib. XXVIII. § 14.

1. IMPORTANCE OF SUNLIGHT AND ELECTRICITY.

The influence of sunlight upon the body and the mind has been recognised from the earliest times. In the *Rigveda* the sun is invoked by Abithapâ «to drive away disease and every evil thought»; and by Vasistha «to preserve us evermore with blessing» (1). And Herodotus, a disciple of Agathinus, says: «The exposure to sunlight is extremely necessary to those who wish to regain their health and to grow strong» (2).

Just as temperature is divided into solar or astronomical, and natural or medical, in the some way light may be considered from two points of view: the astronomical and the medical. The astronomical light at a given point is constant; but the natural or medical varies according to geographical features, and other climatic factors. There is yet no means of indicating the amount or degree of light at any place; the meteorologists do not measure sunlight.

The importance of sunlight upon organised life is now

well established, specially in the vegetable kingdom. The influence of the sun's chemical energy upon the human organism is not so evident, nor that of the atmospheric electricity. But there can be no doubt that both of them exercise some influence. The colour of the sky produces some psychical effects. The influence of moonlight, if any, is not known. In fact the value of all the elements which constitute a climate is not yet well defined. There remain many gaps to be filled up.

2. SUNLIGHT: LUMINOUS AND CHEMICAL ENERGIES.

Besides the thermal, the sun emits, as already stated, two other kinds of energies: the luminous or the optic, and the chemical or the actinic. Each ray of the sun contains all these energies; the difference consists upon its length or upon the substance with which it comes in contact. The sunlight may be direct or bright sunshine, or indirect or diffused sunlight.

The mean number of hours of *sunshine* in winter during 6 years (1903-1908) at Oporto, and during 10 years (1896-1905) at Coimbra and Lisbon, is as follows:

	Dec.	Jan.	Feb.	Total
Oporto	123	155	177	455
Coimbra	134	160	147	441
Lisbon	131	146	148	425

The number of hours of sunshine does not represent the exact degree of the *luminous* energy. As the fi-

gures for Oporto and for Lisbon are not for the same number of years, they cannot be accepted as the basis of exact comparison.

The *chemical* energy or the photo-chemical activity of the rays of the sun is not observed at any of the Portuguese stations. There is no correlation between the luminous and the chemical action. When the sun is low, its direct rays exercise hardly any or no chemical action. Until the sun's altitude is from 16° to 19° degrees, the effects of the direct rays do not exceed those due to diffused light.

The blue colour of the sky is due to the diffusion of the blue rays of the sun. The air of Portugal possesses this property in an eminent degree.

3. ELECTRICITY IN THE AIR AND ITS CAUSES: THUNDER AND LIGHTNING. MAGNETISM OF THE EARTH.

The atmospheric electricity is now attributed to the phenomena of ionisation of the air.

The atoms of the air undergo a continual dissociation into smaller particles known as *ions*, some of which are charged with positive, and others with negative, electricity. The dissociation has been attributed to various causes: to the radioactive emanations from the ground, to the ultra-violet rays of the sun, and to the presence of some radioactive substances of unknown origin.

The ions have the property of causing around them the condensation of the watery vapour in the shape of minute globules. And, eventually, it is the difference in the electricity in the ions that gives rise to thunder,

lightening and rain. The ionisation of the air plays an importance part in the climate of a country.

Brito Capello has published some observations regarding the electric condition of the amospheric air at Lisbon (1). The mean amount of electric tension is: winter 50.89. spring 34.18, summer 62.41, and autumn 60.92. The annual mean is 51.90. In April the electric tension is the least, 12.16; and in August it attains its maximum 85.08. During some days in December and January, the electric tension is much higher than in any single day in August. As a rule, the mean of the maxima occurs during the day and the mean of minima during the night.

Generally speaking, the atmospheric electricity is positive, whereas that of the ground is negative. The number of days, during each season, in which the electricity of the atmosphere is negative is: winter 6, spring 22, summer 8, and autumn 10; total during the year 46. The negative electricity is observed before and during rain, during simple thunder, when there is a sudden change of wind, and during strong and violent winds.

The observations made at some of the stations regarding *thunder* and *lightning* are not satisfactory. At Lisbon the mean number of days of thunder during the year is about 15. The greatest number of storms occur at the commencement of autumn and at the end of spring. The mean number of days on which there was lightning at the 5 stations during 1896-1905 is: Oporto 7.4, Lisbon 9.3, Lagos 0.0, Moncorvo 0.4 and Beja 12.9. Among other stations Coimbra had a mean of 26.2, Guarda of 7.5 and Montalegre of 2.8. It is quite evident that the figures especially regarding

Lagos, Moncorvo, Guarda and Montalegre are not accurate.

Magnetism of the earth. Nothing is known as regards the influence of the magnetism of the earth upon man. Brito Capello was the first to show that the range of diurnal magnetic declination is greatest about the times of the new and the full moons (2).

4. INFLUENCE OF GEOGRAPHICAL FEATURES UPON SUNLIGHT AND ELECTRICITY.

Portugal, owing to its lower *latitude*, receives, comparatively speaking, more direct radiation of sunlight than almost all the other countries in Europe. If the maximum intensity of light be taken at 100: at the equator it is 37.8 p. c.; at 46°, 22 p. c.; and at the poles, 11 p. c. In the lower latitudes the direction of the rays of the sun is less slanting, but in the higher latitudes there is more diffused or scattered sunlight. The chemical intensity of the direct sunlight and skylight are about the same in 41° N. lat. (1).

Thunderstorms are less frequent in high latitudes.

Other conditions being the same, the intensity of insolation increases with increasing *altitudes*. In narrow valleys the amount of insolation is less than in the broad, and it is less in the broad valleys than in the open country. In the northern hemisphere the side exposed to the south gets more sunshine than that exposed to the north. The chemical energy is more intense in the high altitudes than in the plains, and consequently the air of mountains is more aseptic.

It has been found that the radioactive emanations at one of the elevations in Switzerland are 3 to 5

times more than on the plains, and that the number of ions is also greater (2). The electric disturbances or storms are more frequent in mountainous regions.

The influence of the *soil* upon light depends upon the colour of the surface of ground, and upon the smoothness of the surface of rocks. White soils reflect light more than the black, and a rock with a smooth surface more than a loose soil. Just as the reflected rays of temperaiure behave differently from those that are direct from the sun (Ch. vi. 8), in the same manner, Bowles thinks that the «reflected light is not necessarily of the same quality as that which is incident» (3).

The radioactive emanations depend upon the nature of the soil. According to Madame Curie, pitchblend, carnotite, chalcolite and orangite are the most radioactive minerals (4). These and other radium yielding minerals are found in large quantities in the district of Castelo Branco of the Lusitanian region. The air of caves and grottos contains a large amount of radioactive emanations. The electricity of the earth's surface is positive. There is no electricity in the stratum of air to the height of about one metre from the ground.

The surface of *water* has a great reflecting power as regards light. The seashore owes a great part of the usefulness of its climate, especially in winter, to the intensity of sunlight. The exposure of a shore to the south is more effective than the exposure to the north, owing to the declination of the sun in winter.

The air of the ocean contains a larger proportion of ions than similar strata in the plains. The amount of electricity is also greater.

Meadows and *forests* reflect light much less than bare soils.

The influence of forests upon electricity is not well understood; it is believed that in a forest the air is less electric than in open country, and that there is less thunder and lightning.

In large manufacturing *cities*, owing to a great amount of smoke, the amount of sunshine is less than in the suburbs or in the surrounding country. It is probable that the total lower number of hours of sunshine in winter in Lisbon, as compared with Oporto and Coimbra, is due partly to this cause, for the manufacturing quarter of Lisbon is situated to the south-west of the Observatory, whereas there are no such quarters in relation to the Observatories at Coimbra and Oporto. Most of the cities, towns and villages in Portugal are built with a southern exposure, so as to receive the maximum amount of sunshine.

Nothing definite is known as regards the amount of electricity in towns as compared with the forests or open country.

5. INFLUENCE OF OTHER CLIMATIC FACTORS UPON SUNLIGHT AND ELECTRICITY.

When the atmospheric *pressure* is low, as in high altitudes, the yellow rays of the solar spectrum are not absorbed, according to Andressen, to the same extent as when the pressure is high. This gives rise to a difference in the chemical action of the sun (1).

The amount of electricity increases and decreases according to pressure, but the stratum in contact with

the ground to the height of about a metre loses it rapidly.

Winds have no direct influence in the distribution of light, but they influence it indirectly by the distribution of clouds, mists, fogs and smoke. In winter the S. W. winds are accompanied by a large number of clouds (Ch. v. 7), and the N. E. with the lowest number, so that, other conditions being equal, there is less amount of sunshine with the former than with the latter.

Winds carry the radioactive emanations and the ions from one place to another. Generally speaking, the northerly winds are accompanied by positive electricity in the air, and the southerly by the negative. Winds may give rise to electricity due to the friction they cause between various particles of dust in the air.

Evaporation of water, especially when it is not pure, is attended with a greater production of electricity.

The air may contain a large amount of *humidity* or watery vapour and still not prevent the radiation of the luminous rays. There is more electricity in the air when the relative humidity is high and the temperature is cold, than when the humidity is low and the temperature is high.

Clouds, mists and fogs act as barriers to sunlight. There is consequently, broadly speaking, less amount of sunshine in the same latitude on the ocean than on the continent. Clouds may be charged with positive or negative electricity. When the sky is clear, the air contains always positive electricity. The electricity in the air is more while it rains or snows, it is also more when mists are being formed.

There is no connection between luminosity and *tem-*

perature. There may be a high degree of luminosity with a cold temperature and vice-versâ. A greater degree of luminosity can be supported and is agreeable with a cold than with a hot temperature. The chemical energy of the sun does not likewise bear any relation to the thermal, for, sometimes, with a decrease of temperature there is an increase of chemical action.

A high degree of temperature by increasing the evoporation gives rise, indirectly, to an increase of electricity.

6. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS BASED UPON SUNLIGHT AND ELECTRICITY: ISOHELS AND ISOPOTENTIALS.

Lines joining places with the same amount of bright sunshine are termed *isohels*, and lines joining places with the same amount of electricity are termed *isopotentials.*

If the northern hemisphere, commencing with the equator, be divided into 9 belts, each consisting os 10° of latitude, and each with its mean amount of astronomical sunshine, it will be found that 3/5ths of Portugal lie in the 4th belt, and 2/5ths in the central or the 5th belt. Portugal, as a whole, lies in the *isohel* with a mean number of hours of annual sunshine between 2500 to 2750. In winter the northern regions receive, naturally, less amount of astronomical sunshine than the central, and the latter less than the southern.

It has been mentioned that below 41° N. lat. the chemical action of the direct rays of the sun is greater than that of the diffused light; and that the reverse is the case above that latitude. According to this fact,

the whole of the N. Continental region, and all the portion of the N. Atlantic region above the valley of the Douro are less under the chemical influence of the direct rays of the sun than the country lying to the south. These differences influence the vegetation of the respective portions above and below 41° N. lat.

There are no sufficient data to divide the country into *isopotentials*. Owing to the mountainous nature, there are more electrical disturbances in the country above the valley of the Tagus than below it.

As there is a greater amount of evaporation in the south than in the north, it is probable that there is a greater amount of electricity generated in the former than in the latter.

The only portion of the Continent which lies below the lowest latitude of Portugal or which may be expected to receive, other conditions being the same, more amount of bright sunshine, consists of some portions of Andalusia and of Granada in Spain; and of the southern portion of the provinces of Messenia and Laconia in Greece.

According to Dr. Herbertson, «few stations north of England and the southern shores of the Baltic have more than 25 hours' sunshine in December, and only Mediterranean lands receive 100 hours, or 3 ½ hours per day» (1). The mean amount of sunshine in Lisbon is 131 hours, or nearly one-third more than in the Mediterranean lands. In London the mean amount in December is 7 hours at Bunhill Row, 13 at Westminster, and 36 at Kew. April and September have much less amount of sunshine at Bunhill Row than the month of December in Lisbon. The mean in Madrid in December is about 6 to 7 hours less than in Lisbon.

Owing to the presence of a greater amount of humidity in the air, there is a distinct difference in the softness and brightness of the air and of the sky of Portugal as compared with the neighbouring provinces of Spain. Madame Adam expresses her impressions in the following words: «At the frontier of Portugal, the aspect of the country changes as if by a miracle. On entering Portugal, one feels a subtle enchantment. Besides the picturesque scenery, there is something so soft in its light, some all-pervading charm, which entrances one's soul quite irresistibly» (1).

7. EFFECTS OF SUNLIGHT AND OF ATMOSPHERIC ELECTRICITY UPON MAN.

The action of the various rays of the sun as studied experimentally is very complex. The red excite the nervous system, the blue have a sedative effect, and the X rays have a special action upon glands and upon the skin. The violet, the ultra-violet and the radium rays act like the blue, as a sedative and analgesic.

It is difficult to separate the action of the *luminous* energy from the chemical. In the vegetable kingdom the luminous rays cause chlorophyl to split up carbonic acid into its component parts. Plants require more light when the temperature falls, and less when the temperature rises. In human beings, light stimulates metabolism and increases the number of red corpuscles in the blood; it helps the eliminative action of the skin, and increases the amplitude of the respiratory movements. The absence of light gives rise to anaemia and to nervous depression. An abundance of sunshine is beneficial to the tuberculous, the

gouty, the rheumatic, the diabetic, and the convalescents in general; it is injurious to those suffering from diseases of the eye and of the brain. An excessive light or excessive glare may give rise to coryza, headache, sore-throat and slight fever, specially in the feeble, the anaemic, and the neurotic. Some of the beneficial effects of the climates on the seashores are due to the intensity of light.

The *chemical* energy of the sun is seen in the «sunburn» produced especially in high altitudes. It has been attributed to the violet and the ultra-violet rays radiated by the snow. An excessive actinic energy may give rise, in susceptible persons, to erythema and even to blisters. Finsen has shown that the exclusion of chemical rays prevented suppuration in small-pox; and their concentration cured lupus (1). Some of the beneficial effects of high altitudes are due to the influence of greater actinic energy.

It has been estimated that at least 6 hours of sunshine out of 3 days is necessary for the well-being of an invalid. There is no place or station in Portugal where this condition is not fulfilled. And what is more, the intensity of luminosity, even in winter, is, at some places, so great that it becomes at times unbearable.

The influence of the *radioactive* emanations, of *ions*, and of *electricity*, as they exist in the air, is not well understood. When there is a good deal of electricity, in the air, as in the periods preceding a storm, some susceptible persons suffer from mental depression, oppression of breathing, irritation or itching of certain parts of the body, headache, pain in the back, and a general malaise, which disappear when the storm is over. It has to be mentioned, however, that besides

the electrical condition there are other changes in the atmosphere, such as the fall of barometre.

Sunlight considered in its complex effects may be said to be stimulant, tonic, antiseptic, and bactericide. It is one of the great purifiers of the air. The Italians say: *Dove non va il sole, va il medico,* or, «where the sun does not enter, there goes the doctor». The sunlight affects not only the health, but determines also the character of the people. Electricity may act as a stimulant, a sedative, or an alterative.

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CHAPTER VIII.

THE FLORA AND THE FAUNA AS GUIDES TO CLIMATES AND SEASONS.

Each zone of vegetation has a general physiognomy, and each species of plant has its peculiar physiognomy.

DE CANDOLLE: *Géographie botanique raisonnée.* Paris, 1854, vol. 1.º, pg. 18.

1. RELATION OF FLORA AND FAUNA WITH CLIMATES AND SEASONS

In the preceding chapters the vegetation of Portugal has been described as one of the controllers of the various factors of the climate. The object of this chapter is to show how the flora and the fauna act as guides, or as an index, to the nature of the climate and to the march of the seasons.

All the climatic factors combined with the geographical features determine the distribution and the characters of the flora of a country; and, conversely, the phytogeography, or the nature and the extent of the flora, forms a guide to the climatic factors and to the geographical features. Also, the climate combined with the geographical features determines the phenological phenomena of a plant, that is, the time of its germination, the frondescence or the budding of the leaves, the

efflorescence or the budding of the flowers, the formation of the fruit, and the shedding of leaves; and, conversely, the phenology forms a guide to the climate, that is, to the commencement or to the end of a season, or to any delay or advance of a particular date of a season.

In a similar manner, the existence of a particular animal is a guide to the nature of the climate of a country; and the habits of certain animals are a guide to that of seasons, although in both these respects their importance is not so great as that of plants.

The vegetable kingdom exemplifies better the nature of a climate than the animal, for the climate acts more directly upon plants. It acts also more directly upon cold-blooded animals than upon the warm-blooded. As a rule, animals adapt themselves better to a change of climate than plants. The exotic plants and animals are affected more by any decisive change of climate than the indigenous.

Plants have been styled «living thermometres» by Ch. Martins, and «climatometres» by Fonssagrives. They may also be styled *seasonometres*, for, in some respects, they determine better the march of the natural or medical seasons than the meteorological observations.

The foundation of the scientific study of plants in relation to climate was laid by the illustrious Humboldt (1). In Portugal the great pioneer in this branch of study is Barros Gomes (2), whose views have been accepted with slight modifications by almost all the subsequent writers. Among those who have devoted considerable attention to the phytogeography of the whole of Portugal are Willkomm (3), and Daveau (4).

2. DISTRIBUTION OF PLANTS AS A GUIDE TO GEOGRAPHICAL FEATURES AND TO CLIMATIC FACTORS.

The distribution of plants, or the phytogeography of Portugal, forms an admirable guide to the geographical and the topographical features of the country, and to the various factors of its climate. It may be noted here that when a plant is said to grow in a certain region, it does not follow that some specimens of it are not found elsewhere. What is meant is, that it grows better, or has its principal seat, in that region.

The distribution of plants, like the climate, varies according to *latitudes* (Map v.).

In the plains, Humboldt fixed the latitude of the valley of the Tagus as the limit of the cultivation of the date-palm *(Phœnix dactylifera)* (1). Proceeding northwards from the Tagus, the sycamore *(Acer pseudo-Platanus)* has its southern or equatorial limit in the Serra of Cintra, 38°.47′ N. lat.; the common oak *(Quercus Robur)* and the Beira or the black oak *(Q. toza)* at Coimbra and Bussaco, 39°.35′; the birch *(Betula pubescens)* extends to the Serra of Estrela, 40°.10′ and the red pine, or the Scotch fir *(Pinus sylvestris)* to the Serra of Gerez, 41°.45′. Proceeding southwards of the Tagus, the dwarf palm *(Chamaerops humilis)* has its northern or polar limit on the southern side of the Serra of Arrábida, 38°.25′. This is a very important fact, for some botanists consider the polar limit of the palms to be the truest expression of a tropical climate. The carob *(Ceratonia siliqua)*, and the Esparto grass *(Stipa tenacissima)*, have their northern limit in the Serra of Algarve, 37°.25′. It may be mentioned that the rhodo-

dendron *(Rhododendron ponticum)* has its polar limit in the Serra of Caramulo, 40°.34′.

The presence of some plants and the abscence of others are often the signs of certain *altitudes*. The floras of the Serras of Estrela and of Gerez have attracted the attention of several writers since the time of Brotero and Link, but it is Dr. J. Henriques who has studied them best (2).

In the first zone of the Serra of Estrela, or up to an elevation of 400 m., the common oak, the Lusitanian oak *(Quercus lusitanica)*, and the marine pine are the most frequent trees. In this zone the maize is the principal field product; and the olive and the orange thrive exceedingly well; so also does the American aloe *(Agave americana)*. The second zone, from 400 to 1500 m., forms the limit of the cultivation of rye; trees are rare, the Beira oak rises to the elevation of 1000 m., the matgrass *(Stipa gigantea)* is common. Between 1500 and 1700 m., the heaths *(Erica umbellata, E. arborea, E. Lusitanica* and *E. australis)* and the common ling *(Calluna vulgaris)* are frequent. The dwarf juniper *(Juniperus communis* var. *nana)*, the common yew *(Taxus baccata)*, and the birch with pubescent leaves *(Betula pubescens)* are also to be noticed here and there. Between 1700 to 1850 m., the dwarf juniper is very predominant. And above 1850 m. or in the last zone, the most frequent plant is the common matgrass *(Nardus stricta)*.

In the Serra of Gerez the common oak is the most predominant tree up to the height of 1200 m. The common yew and the birch with pubescent leaves are found between 1200 to 1300 m., and only the dwarf juniper and some other bushes are to be met with above 1300 m.

If the distribution of trees in the Serra of Gerez be compared with that of the Serra of Estrela, it is found that, in the former, the holly, the birch with pubescent leaves, and the common yew attain a height of 1400, 1300 and 1300 m., respectively; whereas, in the latter, they rise to 1800, 1800 and 1500 m., or, in the lower latitudes, they rise to a higher elevation than in the higher latitudes. The lower limit of the dwarf juniper at Gerez is 1400, and at Estrela 1500 m. Cold combined with strong wind renders stunted the vegetation on the tops of mountains.

The plants form often a guide to some of the *soils*. Generally speaking, the pines, the chestnuts, the common oak, the barley, the maize, and the rye love a granitic soil; the cork tree, the holm oak, the vine, and the wheat prefer the schistic; and the olive likes best the calcareous. The cork tree, the Beira oak and the holly are indifferent, or grow in soils containing small quantities of lime. The chestnut and the marine pine are calcifuge. An abundance of vegetation indicates a rich soil. Owing to the peculiar climatic conditions due to the soil of the valley of the Douro (Ch. VI. 6), the fig and the almond thrive there just as well as in Algarve. Even the date ripens there.

The *sea* has a flora peculiar to itself, consisting of seaweeds. The sea influences the vegetation on land in two ways: by the saline elements contained in the soil in its neighbourhood, and by the amount of humidity contained in the winds blowing from the sea. The plants which indicate a saline soil are the tamarisk *(Tamarix gallica)*, the glasswort *(Salicornia fruticosa)*, and the sea-purslane *(Atriplex Halimus)*. The sea plants also grow further inland where the amount of

salt in the soil is not great, but the inland plants, as a rule, do not extend beyond a certain limit towards the sea. The crowberry *(Corema album)* is one of the most common shrubs along the coast; so also are the marsh thistle *(Centaurea uliginosa)* and the cringo *(Eryngium maritimum)*. Some trees, as the sweet-gale *(Myrica Faya)*, grow both on the coast and inland. Of the forest trees, the marine pine approaches the coast more than the rest. The poplars *(Populus nigra* and *P. alba)* and the alder *(Alnus glutinosa)* thrive along the borders of rivers or in all marshy soils. The willows or the plants belonging to the genus *Salix* *(S. fragilis, S. alba*, and *S. babylonica)* prefer also the damp soils.

Extensive *plantations* of the Australian gum-trees and of pines are injurious to the growth of undershrubs.

Manufacturing *towns* and cities emitting a large amount of smoke are injurious to vegetation.

The vegetation forms a guide to the nature of *winds*. The inclination of trees and shrubs shows the direction and the force of *winds*. Absence of vegetation on the coast is an indication of strong winds, whereas abundance of vegetation, as in valleys, is a sign of moderate winds or of calm. Winds are useful in the distribution of seeds.

Other conditions being equal, the nature and the extent of vegetation form a good guide to the atmospheric *humidity* and to the amount and distribution of *rain* (Ch. v. 7). Some oaks and other trees, as it will be seen further on, prefer a moist climate and others a dry one, whereas some prefer an intermediate condition. The nature of vegetation also indicates the amount of humidity on the sides of mountains. The olive, which

does not like much moisture, does not extend above 400 m. on the western or the moist side of the mountains in the North Atlantic region, whereas it rises to 800 m. on the eastern or the dry side; on the other hand, the marine pine rises even up to 1500 m. on the western side, whereas it is nearly absent on the eastern.

An examination of the map of vegetation of Portugal framed by Ribeiro and Delgado (3) shows that the density and the luxuriancy of vegetation correspond exactly with the amount of humidity. In the North Atlantic region, where the vegetation is much more dense than in the North or the South Continental regions, the amount of rainfall and of atmospheric humidity is also greater. The freshness of the North Atlantic region in summer is also an indication of a greater amount of rainfall in that season.

Some plants thrive best in a hot *temperature*, others in the cold. The temperature forms one of the factors in the distribution of plants in the plains dependent upon latitude. The olive, for instance, dies if the temperature falls to 10° during a week; it also requires a temperature of more than 14° for the ripening of its fruit. The orange dies if the temperature falls to -10°, even for a few hours. And many orchids perish if the temperature falls to 0°. In fact, the limit of certain plants depends upon the mean temperature in winter, or upon the isochimenics of the country. The isochimenic 5° marks the limit of the olive; and the isochimenic 0° that of the beech, chestnut and mulberry.

The growth and the acclimatisation of the tropical and subtropical plants form a good guide to the temperature of a place or of a region. In many parts of Portugal the date palm, the anona *(Anona Cherimolia),*

the prickly pear *(Opuntia Ficus-indica),* the pomegranate *(Punica Granatum),* the pumelo or the paradise apple *(Citrus decumana),* the American aloe *(Agave americana),* and many others grow exceedingly well.

The influence of *sunshine* in the distribution of plants is not so evident as that of other climatic factors. The vegetation of places exposed to bright sunshine is more luxuriant than that where there is less light. Plants exposed to light flower in greater abundance than those in the shade. Intense sunlight, combined with a high temperature, imparts a distinctive rich flavour to the grapes in the valley of the Douro and of some of the places in the district of Lisbon. Even when the temperature is high or equal, the ripening of dates is earlier in a place with a bright sunshine. The stone pine *(Pinus Pinea)* grows best where there is a great amount of light.

3. PHENOLOGY AS A GUIDE TO THE MARCH OF SEASONS.

The vegetative life of certain plants forms a good guide to the nature of the seasons, and also to their commencement or to their termination. The mere examination of the meteorological register does not show why the same plant flowers earlier in one year and later in another, and why the same plant flowers only once a year in one region and twice a year in another.

A moist season is favourable to the vegetative life of a plant, and a dry one to its reproductive functions. When the climatic conditions are favourable or resemble those of a hothouse, then there is a rapid growth, and

all the vegetative and reproductive functions occur almost without any intermission.

Coimbra is the only place where phenological observations are recorded by Sr. Moller, of the Botanical Garden. Dr. Ihne, of Darmstadt, has framed a table of 42 plants based upon these observations, showing the mean dates, during the years 1883 to 1897, of the first appearance of leaves, the opening of the first flower, the ripening of the first fruit, and the general discoloration of leaves (1). Only the dates of the appearance of the first flowers in a few trees need be mentioned here.

11	Feb.	Japanese quince *(Cydonia japonica)*.
5	March	Blackthorn *(Prunus spinosa)*.
14	»	Quince *(Cydonia vulgaris)*.
15	»	Prune *(Prunus avium)*.
18	»	Pear *(Pyrus communis)*.
22	»	Judas tree *(Cercis Siliquastrum)*.
28	»	Hawthorn *(Cratægus oxyacantha)*.
29	»	Horse-chestnut *(Æsculus Hippocastaneus)*.
6	April	Apple *(Pyrus malus)*.
11	May	Raspberry *(Rubus idæus)*.
18	»	Vine *(Vitis vinifera)*.

It is hardly necessary to remark that Coimbra is by no means the best type of the Portuguese climate. The most distinctive types are to be found on the shores of the Lusitanian and the Mediterranean regions.

The peach, the apricot, and the cherry flower at Portimão in the first week of February, and the apple in the second: at Oporto the former flower in the middle of the month, and the latter at the end. A

similar difference is noticeable in proceeding from west to east. The zinnias, pinks, balsams, and summer chrysanthemums, if sown at the commencement of March at Mont'Estoril, flower at the commencement of June; whereas the same plants, sown at the same time in Lisbon, flower after six weeks; and at Santarem, after two months. In the elevated parts of the country the flowering takes place about one month later than in the plains. At Mont'Estoril almost all the garden plants thrive just as well in winter as in spring, or in summer. In connection with this subject it is most interesting to notice that more than 2000 years ago, Polybius, who made a voyage to Portugal in a yacht placed at his disposal by Scipio Emilianus, remarked from his personal observation that in Lusitania «the flowers of the roses, the lilies *(Leukoia)*, the asparagus, and other similar plants, are wanting only during three months of the year» (2).

The ripening of crops depends not so much upon the mean seasonal temperatures as upon the mean temperature of each day. Where the mean temperature of each day is higher, the crops are earlier and better than in places where the mean temperatures are lower. The harvest takes place, according to situation, at the end of June, and in July and August; and the vintage in September, October, and November. Green peas can be cultivated in the open air, in favourable situations, throughout the year.

The leaves appear much earlier in the south than in the north. In 1908 the fig-trees shot their leaves at Portimão on the 22nd March, and at Mont'Estoril on the 25th.

Different species of the same genus of trees thrive

better in the climate of one region than in that of another, and have accordingly either evergreen or deciduous leaves. In the South Continental region, owing to the great heat and to the dryness of the air, the leaves of the cork tree *(Quercus Suber)* and the holm-oak *(Q. Ilex)* fall prematurely; whereas in the North Atlantic region, owing to the cold and moist climate, the leaves of the common oak *(Q. Robur)* and of the Beira oak *(Q. tozza)* are perennial. In the Lusitanian region, the Lusitanian oak *(Q. lusitanica)*, says Professor Pereira Coutinho, «forms in a way a transition between the evergreen and the deciduous oaks: it is intermediate in its climatic needs as well as in its organisation. In fact it has, like the former, coriaceous leaves, fit to prevent the evaporation caused by a hot climate, but they are deciduous like those of the latter. Moreover, the fall of the leaves is later in the Lusitanian oak than in the common and the Beira oaks, for these shed their leaves in autumn, whereas the former sheds them at the end of winter» (3). The kermes oak *(Q. coccifera)* partakes the characters of the cork-tree, and the dwarf oak *(Q. humilis)* those of the Lusitanian.

Owing to the peculiar and characteristic climate of the Portuguese Riviera, there is in almost all plants a very active elaboration of sap, so that the vegetative life of a plant may be said to be dormant only for about two months: from the middle of July to the middle of September. This portion of the Lusitanian region may be said to form a sort of a hothouse of the whole Continent.

Considered from the phenological point of view, the plains of Portugal, especially in the Lusitanian region,

present a climate consisting of two springs and a summer: the first or the mild spring lasts from October to February, and the second or the full spring from March to June, the remaining months forming the summer. In the first or the mild spring the orange, and often the cherry and the pear flower and yield fruit for the second time during the year (4).

4. THE DISTRIBUTION OF FAUNA AS A GUIDE TO GEOGRAPHICAL FEATURES AND TO CLIMATE FACTORS.

The distribution of the fauna or zoogeography has not been studied in the same manner and to the same extent as the phytogeography. The subject is difficult, for animals have not a fixed habitat like plants; and countries with similar geographical features and climates are inhabited by different animals owing to the differences in food supply. It is not easy, therefore, to establish always a correlation between animals and the geographical features and climatic factors of any country.

Among the wild *mammals*, the wild goat (*Capra lusitanica*) is limited to the Serra Amarela, but it is becoming, year after year, very scarce. The roebuck is found in the Serra of Gerez, and the wild boar in Alemtejo, where it finds an ample supply of food in the catkins of the holm oak and the cork tree. The wolf, the fox, and the wild cat have been noticed at Coimbra, Leiria, Castelo Branco and Evora. The seal is found at Buarcos; and the badger and the otter in or about Coimbra, Leiria and Estarreja. The lynx inhabits various parts from the Serra of Estrela to Evora. The hare and the rabbit are common. The

fallow-buck has disappeared except in certain private preserves.

Some *birds* inhabit the whole country; some are found in the north and others in the south; some prefer the seashore and the plains, and others the mountains and the plateaus. There are about 312 species of birds in Portugal. The latest catalogue of the Portuguese birds is by Sr. Seabra (1), and one of the best for the discription of habits of some of the species is by Mr. Tait (2).

The following birds are common everywhere: the storm-cock *(Turdus viscivorus)*, the blackbird *(T. merula)*, the partridge *(Caccabis rufa)*, the sparrow-hawk *(Chercneis tinnunculus)*, the screech-owl *(Stryx flammea)*, the black starling *(Sturnus unicolor)*, the magpie *(Pica pica)*, the raven *(Corvus corone)*, the crested lark *(Galerita cristata)*, the sedge-bird *(Anorthura trogloditis)*, and the yellow wagtail *(Motacilla melanope)*.

Those which have their habitat chiefly in the north are the common dipper *(Cinclus aquaticus)*, the black chat *(Saxicola leucura)*, the sedge-warbler *(Acrocephalus Schoenobaenus)*, the kite *(Buteo vulgaris)*, and the jay *(Garrulus glandarius)*. And those common in the south are the blue rock-thrush *(Monticula cyanus)* and the red kite *(Milvus milvus)*.

The following prefer the coast: the seamew *(Larus cachinnans)*, the black-winged gull *(L. fuscus)* and five other species of sea-gulls, the sea-raven *(Phalacrocorax carbo)*, the sea turtle dove *(Strepsilas interpres)*, and the coot *(Aegialitis alexandrina)*. The kite *(Circus Aeruginosus)* prefers the saltpans, and the heron *(Ardea cinnerea)* frequents the borders of rivers. The woodwren *(Phylloscopus sibilatrix)* prefers the mountains.

The coast of Portugal is on a line between the northern breeding ground of many species, and the southern winter quarters of many others.

The climate has an influence on the plumage. In Portugal the birds have, as a rule, a darker plumage than in the north.

Among the *amphibians*, the Lusitanian chioglossa *(Chioglossa lusitanica)* is peculiar to Portugal, and is found from Cintra northwards. The frog and the toad are found everywhere, but the Iberian frog *(Rana iberica)* and the green toad *(Bufo calamita)* are limited to the north of Coimbra.

Among the *reptiles,* the vipers are represented by two species: the common viper *(Viper Latastei)* is found in various parts, and the black viper (*V. berius*, var. *prester*, which is not so poisonous as the species) is limited to the Serra of Suajo and some other mountainous parts of the north.

The Lusitanian Sea, owing to its great depth and the variety of currents, is extraordinarily rich in the number and the variety of *fishes*. This fact was known to Polybius, who says that the fishes are much superior to those of the Mediterranean Sea «by their abundance, by their excellent quality and by their beauty». Up to the present time about 270 species have been classified. The varieties of sea-fish do not form a good index to the climate, for the climate depends more upon the temperature of the water on the surface than of that below it, whereas the varieties of fish depend more upon the temperature and currents of water below the surface. Among the most curious specimens are the *Saccopharynx ampullaceus* and the *Himantolopus Gröenlandius*.

The distribution of fishes in the rivers is of greater importance, for they characterise more the climate of the country. This subject has been studied by Prof. Nobre (3). In the river Minho are found the salmon and the trout; and in the Guadiana, the sturgeon and the carp; whereas the lamprey and the chad are common in all the rivers. The Minho forms the polar limit of the salmon; and the Douro forms, as far as Portugal is concerned, the equatorial limit of the sturgeon and the carp. *Carasius vulgaris* is found in the Douro and the Vouga; and *Acipenser Nacarii* in the Guadiana. The coast of Portugal is very rich in molluscs.

The distribution of some of the races of *domesticated animals* is of interest. The bovine races known as the *Galega,* the *Barrosa* and the *Arouca* are found in the North Atlantic region; the first in the plains between the Minho and the Douro, the second in Barroso, and the third chiefly in the district of Vizeu. The *Wild,* the *Turina,* and the *Miranda* races are limited mostly to the Lusitanian region. The *Trasntagana* thrives best in the Mediterranean and in the South Continental regions, and the *Miranda* in the North Continental. The other domestic animals, such as horses, mules, donkeys, goats and pigs, present different races and varieties distributed in different parts of the country (4). The *Churro espanhol,* a sub-race of the Spanish sheep, for instance, thrives best in the dry climate of Alemtejo, and deteriorates when transferred to other districts.

5. THE FAUNA AND THEIR HABITS AS AN INDEX TO THE MARCH OF SEASONS.

The life cycle of various animals, and their habits, if properly observed, would furnish excellent guides to the march of the natural or the medical seasons.

The seasons determine the nature and the duration of the life of many animals. Most of the invertebrates are annuals, and their life is limited to the hot season. A minute examination of the 2,329 Portuguese insects would furnish many useful indications. Some insects die when there is a sudden drop of temperature.

Portugal affords an excellent position for the observation of the *migration* of birds, for its coast and the neighbouring plains form the main course taken by the West Atlantic marine birds in their flight northwards or southwards as the case may be. As yet there are no accurate observations to determine the mean dates on which the various species present themselves at different places. Some birds remain in the country nearly the whole year, some make their appearance in summer, and others in winter. In spring there is a flight from south to north, and in autumn from north to south; some migrate owing to a change in the seasons, and others in the search for food, so that all the migrations are not to be attributed to climate alone.

The swallow *(Hirundo rustica)* arrives in some parts of the country in the middle of January and leaves in the middle of November. The mean date of its arrival at Coimbra, from 15 years' observations made by the late Sr. Rosa de Carvalho, is 10th February, and the

mean of departure, 13th October (1). At Oporto it arrives, according to Mr. Tait, between the 8th and the 15th March, and leaves in the middle of November. The quail *(Coturnix coturnix)*, and the stork *(Ciconia ciconia)* are absent during winter.

The song-thrush *(Turdus musicus)* arrives in the beginning of October and leaves in the beginning of April. The woodcock *(Scolapax rusticula)* arrives at the end of October and disappears usually in February. The snipe *(Gallinago galinago)* comes in the middle of August and remains till the commencent of March. Prof. Mattozo Santos informs me that the Cape-bustard *(Otis capensis)* visits occasionally the Cape St. Vincent in winter. The nightingale *(Eritacus Luscinia)* arrives at the end of April and leaves in October. The subalpine warbler *(Sylvia subalpina)* comes in May and leaves in September. And the turtle dove *(Turtur turtur)* arrives in March and departs in September.

A minute examination of the appearance of certain species of fishes would be useful in determining the seasonal characters as well as the direction of certain winds.

6. CLASSIFICATION AND CHARACTERS OF THE FIVE CLIMATIC REGIONS BASED UPON THEIR FLORA AND FAUNA.

Köppen has proposed an excellent classification of climates from the botanical point of view (1). He divides them into five classes based chiefly upon temperature and moisture. Only a few words can be said here regarding the characteristics of each class.

1) *Megatherms*, or plants which need a continual high

temperature with abundant moisture, such as sugar-cane and banana.

2) *Xerophytes,* or plants which require less moisture but a high temperature at least for a season, as acacias, cactus, and agave.

3) *Mesotherms* need moderate heat and a moderate amount of moisture, as olive, fig, and grapes.

4) *Microtherms* need less heat, lower mean annual temperature, cooler and shorter summer, and colder winter. In this class are found evergreen and deciduous forests in the colder portion, and fruit and corn in the warmer.

5) *Hekiototherms*, or plants of the Arctic zone, such as mosses and lichens.

Considered as a whole, Portugal belongs to the mesotherms and the xerophytes, the microtherms being limited to the tops of mountains. Madeira approaches the megatherms.

Barros Gomes (2) divides Portugal into three botanical regions: 1) the country to the south of the Tagus or the region of the deciduous oaks; 2) the country to the north of the Tagus or the region of the marine pines; and 3) the country to the extreme north or the region of the evergreen oaks. He subdivides his regions into 12 floral provinces, 5 littoral and 7 inland. The littoral are: Littoral beyond the Douro, Littoral Beira, Littoral Centre, Littoral Low Alemtego and Algarve; and the inland are: Transmontane Douro, Central Beira, Southern Beira, Lowlands of the Sorraia, Highlands of Alemtego, and Lowlands of the Guadiana. Each of these provinces is characterised by the predominance of two, three or four out of the following ten most common forest trees: the common, the Beira,

the Lusitanian, the holm, and the cork oaks; the marine and the stone pines; the chestnut, the olive and the carob. The main principles of the classification of Barros Gomes are agronomic.

Generally speaking, the most prevalent forest trees in each of the five climatic regions are:

North Atlantic: common oak, marine pine, and Beira oak;

Lusitanian: marine pine, Lusitanian oak, and stone pine;

Mediterranean: carob, holm oak, and olive;

North Continental: Beira oak, and chestnut;

And South Continental: cork tree, holm oak, and stone pine.

As regards the main cereal products, the maize is cultivated chiefly in the north; the rye in the mountainous districts; and the wheat in the centre and the south. The oats and barley are cultivated side by side with wheat; and the rice in the valleys or lowlands bordering on the principal rivers. It is worthy of note that of all regions of the Iberian Peninsula it is only Portugal that produces, in a normal year, breadstuffs sufficient for its population.

If the northernmost and the southernmost floras of Portugal be compared with those of other countries, it is found that many of the species indigenous of Minho grow likewise in the south-western coast of England and of Ireland, and also in the Pyrenees and in Germany; and many of the species found in Algarve grow equally well in the northern and southern coasts of the Mediterranean Sea.

In comparing the flowering and fruiting of the peach, the cherry and the apple at Oporto, Coimbra, Lisbon

and Portimão with places in nearly the same latitude in America, as Boston, New York, Lexington and Richmond, it is found that they occur from two weeks to two months earlier in Portugal (3).

If the dates of the occurrence of the various phenomena of phenology given under § 3 be compared with those in other countries in Europe, it is seen at once how the vegetative and reproductive functions of the same plants take place much earlier and are much more continuous in Portugal. In the British Isles, for instance, the blackthorn *(Prunus spinosa)* the hawthorn *(Crataegus oxyacantha)* and the horse-chestnut *(Aesculus Hippocastaneus)* flower, respectively, on the 101st, 136th and 130th days of the year (4); while they flower on the 64th, 87th, and 89th days at Coimbra; the mean difference between the flowering periods being 46 days. A similar difference is noticeable in the flowering of the almond and mimosas in the French and the Italian Rivieras as compared with the Portuguese Riviera.

Like other countries of its size, Portugal cannot be divided into distinct zoogeographical regions, or in other words, each of the five climatic regions do not offer, at present, sufficiently distinctive bases of classification. The country, as a whole, belongs to the Sub-Mediterranean zoological province, or contains species of animals found in southern Europe and northern Africa.

The migration of birds from the south is much earlier in Portugal than in almost all other countries. In Paris the swallow appears on the 10th April, or exactly two months later than at Coimbra.

7. DOES PORTUGAL FORM A BOTANICAL UNIT? THE LINE OF JUNCTION OF THE POLAR AND THE EQUATORIAL CLIMATES ON THE WESTERN COAST OF EUROPE AS DETERMINED BY THE FLORA.

M. Daveau, of Montpellier, who has devoted considerable attention to the flora of Portugal, and whose opinion may be considered to be quite unbiassed, says that, if the extreme north and the extreme south be excluded, «we are in the presence of a sort of ***natural region*** with floral characteristics so clear, and with a proportion of endemic plants more remarkable than that of any other country of Europe» (1).

Several examples can be quoted in confirmation of this view, but one will suffice. Out of the 25 species of thrift *(Armeria)* found in Portugal, 12 or nearly one-half are exclusively limited to this country, whereas out of 30 species found in Spain, only 10 or one-third are exclusive to that country. And what is of still greater importance is that the Portuguese species are to be found exactly in those portions of the country which have a distinctive climate, such as the peninsulas of Roca, Espichel and St. Vincent.

The distinctive nature and extent of the Portuguese flora is evident even to a casual observer in crossing by rail the western frontier of Portugal at Barca de Alva, Vilar Formoso, Valencia d'Alcantara, and Elvas, where the differences in the vegetation represent very closely the political boundaries between Portugal and Spain. Portugal is so rich in its flora that Grisley, the author of *Viridiarum Lusitanum*, did not hesitate to style it *Hortus Europæ* or «The Garden of Europe».

Judged by the phytogeography, the *line of junction* of the polar and equatorial botanical provinces on the western coast of Europe lies between the Serras of Arrábida and Cintra, or between the parallels of latitude 38° and 39°, and this line corresponds with the mean temperature of the earth (Ch. VI. 6). It does not lie in 45° North latitude or on the coast of Bordeaux, nor does it lie at Lavos, 40°.8', or in Woeikof's axis (Ch. IV. 2). The lat. 38°.25' forms the northern limit of the indigenous palm; and the lat. 38°.47', the southern limit of the sycamore. In the valley of the Tagus the marine and the stone pines, and some other plants of the northern and southern regions, mix in a happy combination (4). All these are important facts.

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CHAPTER IX.

CLASSIFICATION OF THE CLIMATES OF PORTUGAL.

A good classification forms the pivot of all advancement of scientific knowledge.

I. ON THE BASES OF CLASSIFICATION OF CLIMATES FROM THE MEDICAL STANDPOINT.

There is yet no satisfactory classification of climates from the medical standpoint. Many authors base their classification upon the relative position of land and water (Ch. II. 6); some upon temperature; others upon a combination of temperature and humidity; and a few upon a combination of temperature, humidity and force of winds. From the historical point of view there is a classification which is well worthy of record. It is the once famous and now almost forgotten table framed by Dr. Lynch (1), showing how certain degrees of temperature predispose or give rise to certain diseases.

No single factor of climate gives a better clue to the distribution of other factors of climate than winds. In fact, the winds and breezes form, at last for the present, the only rational basis of what may be termed the Natural System of Classification of the Medical Climates of Portugal. It is not always easy to classify a given place, but it is likewise not easy to classify a plant or

an animal. There is no reason why everybody should be able to classify a climate at first sight. All climates based upon the origin of winds may be divided into four *classes* or *genera,* and a country, whenever possible, may be divided into four main *sections,* namely:

1). Climates completely or almost completely under the influence of sea-winds, or the open *oceanic* and the *insular* section;

2). Climates mainly under the influence of sea-winds, or the *marine* section;

3). Climates mainly under the influence of land-winds or the *continental* section;

4). And climates completely or almost completely under the influence of land-winds, or the *desert* section.

This classification is nearly the same as that based upon the relative position of land and water, but with this important difference: the relative position of land as regards water is no positive criterion to the nature of the climate, for a region, like the S. Continental, may be very near the sea and still not have a marine climate. On the other hand, where the winds from the sea are strong, and the configuration of the country is favourable, as in some portions of the N. Atlantic and the Lusitanian regions, the marine climate may be carried far inland. The winds, therefore, form a better or natural basis of classification than the mere relative position of land and water. Some writers confound the marine climate with the open oceanic or the insular, and others confound the continental climate with the desert.

Portugal with the adjacent islands of the Azores and Madeira may be divided into 3 sections: the open oceanic and the insular, which will be described under

Ch. XIX; the marine; and the continental. The Continental section of Portugal is only very mildly continental. There is no Portuguese climate belonging to the fourth or the desert section, the characters of which are nearly in all respects the reverse of the oceanic.

The breezes constitute an important element of medical climates. Based upon breezes and winds, some of the sections, in which the breezes are well developed, can be divided into *zones*.

Based upon the principle of the prevalence of wind from one or two points of compass, each section can be divided into *regions* (Ch. IV. 5). And each region may be subdivided, whenever possible, into *subregions*. The subdivision is based partly upon the zones of which the region is composed, and partly upon the principle that a wind proceeding from the southern quarter loses gradually its temperature and gains in humidity in proceeding northwards; and, inversely, that a wind proceeding from the northern quarter gains gradually in temperature and loses its humidity in proceeding southwards. There is a similar increase and decrease of temperature and humidity in winds from west to east and vice-versâ. In winter, a wind from west to east loses its temperature and gains in humidity; in summer, the east winds gain in humidity and become somewhat cooler on approaching the sea. Many of the subregions described in the following pages correspond more or less with the floral provinces of Barros Gomes.

All climates of altitudes, forests, and large cities have some distinctive climatic characters of their own, due in the case of the two first to their breezes. They constitute *sub-classes*. They partake the general character of the section in which they are situated.

The classification of climates based upon winds gives a clue to the nature or the class of climate, but it does not indicate the actual means of the various factors, for a marine or a continental climate may lie in the tropical as well as in the temperate or the polar belt. The means of temperature, of sunlight and of some other factors may be more or less estimated upon the bases of latitude, altitude, nature of the soil, the proximity of the oceans and rivers, and the amount of vegetation, but they have always to be checked by actual observation. Before the perfection of the thermometre, writers, such as Amatus Lusitanus and Zacutus Lusitanus, paid a great deal of attention to the latitude of a place. From the references already made to this subject (Ch. II. 2) and to be made further on (§ 7), the latitude of a place, within 6°, 7° or even more degrees, has not, under certain circumstances, much importance.

The means of temperature determine the class of temperature to which it belongs, that is, whether it is torrid, hot, warm, temperate, cold, very cold or polar (Ch. VI. 9). The means of humidity show whether they are very dry, dry, moderately dry, moderately moist, moist and very moist (Ch. V. 10). A combination of a class of temperature with a class of humidity constitutes, for practical purposes, the *species* of a climate. If to the species be added the typical characters of the other factors of climate, such as the force of winds, barometric pressure, evaporation, rain, mists, fogs, sunshine, and electricity, it is evident that the number of the *types* or *varieties* of climates is indeed extremely numerous or infinite. It is not easy to define subjectively, the physiological effects of a climate and its

therapeutic uses, just in the same way that it is not easy to say what are the effects and uses of 50 grams of alcohol. They depend or vary according to the age, the temperament, the constitution, the habits, and the causes and the nature of disease. It is not easy to define, likewise, in cases where the mortality is higher than the normal, the pathological effects of a climate, for in such a case the causes of mortality have to be taken into account (Ch. XI. 6). It may be mentioned that there is a greater amount of changes in the factors of climates in the temperate than in the other belts. The physiological effects and the therapeutic uses of climates are more or less constant, whereas the pathological effects are greatly under the control of man.

The study of the forecast of weather, especially at long periods, is of great importance not only to an invalid but also to an agriculturist, to a navigator, and to various other classes of persons; but unfortunately this branch of study is still in its embryonic stage.

2. THE MARINE SECTION, OR THE PORTION OF THE COUNTRY MAINLY UNDER THE INFLUENCE OF SEA-WINDS: ITS ZONES, REGIONS, AND SUBREGIONS.

The marine section of Portugal comprises the whole of the territory with the exception of the portion of Traz-os-Montes to the east and to the north of the chains of Marão and of Montemuro, respectively; and of that portion of Alemtejo which lies, roughly speaking, between the Serras of Ossa on the north, of Algarve on the south, and of Cercal on the west.

This section can be divided into 3 *zones:* the littoral, the sea-breeze, and the inland sea-wind.

1) The *littoral* or the *saline* zone consists of the tract of land extending from the coast, where the surface is flat or gently rising, to a distance of about 5 to 6 km. inland. Its characters are: the air is impregnated with a large amount of saline elements, which render the soil more or less saline; it contains a large percentage of absolute humidity; it is very pure and contains a large quantity of ozone. A littoral zone varies greatly in the degree of its salinity. It may be very saline or very feebly saline. Everything depends upon the force and the direction of winds, and upon the elevation and configuration of the coast. The saline taste is felt only on the shore when there is a spray. This zone is characterised by a mild winter and a moderate summer; and it has a distinctive vegetation. The shores exposed to the south have a more marine climate in winter; and those exposed to the north a more marine climate in summer. These differences are very noticeable on the northern and the southern shores of the Bay of Cascaes.

2) The *sea-breeze* zone extends from the littoral zone to a distance of nearly 50 km. inland, or up to the limit where the sea-breezes are felt. A slight elevation, or even a large belt of tall trees, modifies considerably its extension inland. The characters of this zone are: the temperature is lower, and the moisture is greater especially in summer, rendering its climate more equable than in the next zone. Compared with the saline zone, the winds are less strong, and the air is less pure.

3) The *inland sea-wind*, or the *marine air*, zone comprises the whole of the marine section beyond the sea-breeze zone. Its limit depends upon the disposition

of the mountains and of the valleys. Its characters are: the temperature is more variable than in the preceding zone; the relative humidity is greater in winter and less in summer; the velocity of winds on the plains is more moderate; and the air is less pure. This zone is characterised by the presence of the marine pine.

The marine section consists of three *regions:* the N. Atlantic, the Lusitanian and the Mediterranean, each of which is represented by the climates of Oporto, Lisbon and Lagos, respectively. The boundaries of each of these regions have been already defined. It is now proposed to define the climatic characters of each of them considered as a whole.

I) The N. Atlantic Region.

The prevalent annual, winter, and summer climatic factors of this region are:

	An.	Wt.	Sm.
Prevalent winds	S. W., S.	S. E., E.	N. W., W.
Temperature	14°.32	9°.08	19°.59
Yearly fluctuation	12°.32	—	—
Diurnal range	7°.54	7°.30	7°.66
Extreme range	21°.5	10°.5	20°.5
Evaporation mm.	829	155	251
Relative humidity	77.5	80.7	74.9
Rainfall mm.	1233	477	121
Mean number of days of rainfall	158	47	22
Velocity of wind km.	15	17	14

This region consists of 3 *subregions,* two of which are littoral, the northern or the Minho, and the southern

or Beira Mar; and one inland, consisting of Beira Alta. It is hardly necessary to repeat that the boundaries of the subregions do not always correspond with the boundaries of the provinces after which they are named.

1) The *subregion Minho* is bounded on the east by the Serra of Marão, and on the south by a line extending through the crest of the Serra of Montemuro to Vila Nova de Gaia, and separating the basin of the Douro from that of the Vouga. In this subregion the chemical influence of diffused sunlight commences to be greater than that of the direct rays of the sun (Ch. VII. 4). In proceeding northwards from Oporto, there is a decrease in temperature and an increase of humidity and of rainfall. The sea-breeze zone is comparatively limited; but the mountain breezes are well developed and approach the coast. The air is intensely marine in winter. The influence of the S.W. winds is felt even in summer. The climate of the extreme north is represented by Guardia, a Spanish town, situated on the right bank of the Minho; its temperature, considering its altitude, is 1° less than that of Oporto, and the rainfall is 30^{mm} more (1899-1900). As a specimen of climate in the plains, may be mentioned Penafiel, $41^{\circ}.17$ N. lat., and 30^{km} from the coast, the mean temperature of which is $1^{\circ}.68$ higher than that of Oporto; and as a specimen of altitude, Montalegre, 1.027^{m}, the mean of which is $3^{\circ}.85$ lower.

2) The *subregion Beira Mar*, or the Netherland of Portugal, consists of the plains of the districts of Aveiro and of those of Coimbra. It is bounded on the east by a line drawn from Vila Nova de Gaia to Coimbra, and on the south by a line extending through the crest

of the Serra of Sico down to Lavos across the hills of Albergaria. Its climate is considerably modified by several lagoons which traverse it along the coast of Aveiro. In proceeding southwards, there is an increase of temperature and a decrease of relative humidity and of rainfall. Figueira da Foz, which lies towards the extreme south, has the mean temperatures of $4^{\circ}.8$ in winter and $4^{\circ}.3$ in summer higher than those of Oporto; and the amount of rainfall about 200^{mm} less. Coimbra, situated to the extreme east, has the mean temperatures in winter and in summer higher than those of Oporto by $0^{\circ}.58$ and $0^{\circ}.39$, respectively; the relative humidity is less by $4^{\circ}.7$ and $6^{\circ}.2$; and the rainfall in winter less by 222^{mm}.

3) The *subregion Beira Alta* comprises all the altitudes and valleys beyond the eastern frontier of Beira Mar. The valleys of the Vouga and the Mondego convey the marine winds right up to the frontier. Compared with the littoral subregion, its general climate is colder and moister in winter, and drier and cooler in summer. Bussaco represents the climate near the western limit, and Guarda, which forms a point of junction of the N. Atlantic and the Lusitanian regions, represents the climate on the eastern frontier. Vizeu, $40^{\circ}.39$ N. lat., and 540^{m} in altitude and $64^{km.}$ from the sea, has a mean temperature of $13^{\circ}.7$, a relative humidity of 61, and a rainfall of $1{,}044^{mm}$.

The three subregions are characterised by three trees: the northern by the common oak *(Quercus Robur)*; the southern by the Lusitanian oak *(Q. lusitanica)*; and the eastern by the Beira oak *(Q. toza)*. The Lusitanian oak forms a connecting link between the N. Atlantic and the Lusitanian regions.

II) The Lusitanian Region.

The annual, winter, and summer climatic means are as follows:

	An.	Wt.	Sm.
Prevalent winds in the plains.....	N., N. W.	N., N. E.	N, N. W.
» » » » highlands..	S. W.		
Temperature	15°.91	10°.78	21°.01
Yearly fluctuation..............	11°.87	—	—
Diurnal range.	6°.80	5°.37	8°.41
Extreme range..................	16°.4	13°.1	19°.1
Evaporation................mm.	1047	89	475
Relative humidity..............	6.18	70.0	53.5
Rainfall...... ....mm.	640	259	39
Mean number of days of rainfall...	113	42	8
Velocity of winds............km.	18	17	19

The Lusitanian and the N. Atlantic regions are separated from one another by some very distinctive geographical and climatic features, specially in the plains.

a) In 40° degrees N. latitude, or at Lavos, ends the main offshoot of the Serra of Estrela.

b) In 40° commences the axis of Woeikof (Ch. iv. 2).

c) In 40°, the Gulf Stream divides itself in winter into two branches: the northern and the southern.

d) To the north of 40° there is a distinct prevalence in winter of the S.W. winds, and to the south of the N. and N.W.

e) Above 40° there is a greater amount of relative humidity and of rainfall than below it.

f) Above 40° there is rain both in winter and in summer; below 40° the rainfall is chiefly in winter.

g) To the north of 40° the sea is warmer than the land; below 40° the reverse is the case.

h) And 40° forms the equatorial limit of the birch (*Betula alba*).

The Lusitanian region consists of 5 *subregions,* three littoral: the northern, the central, and the southern Estremadura; and two inland: Beira Baixa, and the eastern Estremadura.

1) The *subregion Northern Estremadura* is bounded on the north by Beira Mar, on the south by the crest of the Serra of Cintra and on the east by the Serras of Monte Junto and Aire. It forms a connecting link between Beira Mar and Central Estremadura. The temperature of San Pedro de Muel, on the coast towards the northern boundary, at 9 o'clock is 14°.8, the mean in winter being 10°.3, and in summer 18°.2; the rainfall is 571^{mm}. The temperature of Marinha Grande, situated $9^{km.}$ inland and nearly in the same latitude as San Pedro de Muel, is lower than that of Lisbon by 2°.41, and the rainfall is higher by 86^{mm}. Mafra, towards the southern boundary has a mean temperature lower than that of Lisbon by 1°.7; the winter being cooler by 0°.9, the spring by 1°.3, the summer by 3°.10, and the autumn by 1°.7. The climate of the Serra of Cintra towards the north has a great resemblance to the climate of the N. Atlantic region. Its temperature, as observed at an altitude of 205^{m}, is 2°.1 higher than that of Lisbon in January, and 2°.20 lower in July. When the observatory is transferred to the centre of the town, as it is proposed to do, the temperature in winter will not be so high, and the temperature in summer will be lower.

2) The *subregion Central Estremadura* is bounded

on the north and the south by the ridges of the Serras of Cintra and of Arrábida, respectively, and on the east it is separated from the Eastern Estremadura by a line drawn from Monte Junto to Monte Palmela, or by a line separating, more or less, the sea-breeze zone from the inland sea-wind zone. This subregion is small, but it is the most important of all in winter. Its climate is represented by Lisbon and by the Portuguese Riviera. Its temperature is the same as the mean of the earth; its climate is more constant and more equable than that of any other similar region on the Continent; and it forms the point of junction of the polar and equatorial climatic influences on the western coast of Europe as evidenced by its flora.

3) The *subregion Southern Estremadura* is bounded on the north by the ridge of the Serra of Arrábida, and on the east by a line drawn from Monte Palmela down to Cape St. Vincent through the Serras of Cercal and Espinhaço do Cão. Its climatic interest lies in the southern aspect of the Serra of Arrábida, including Palmela and Setubal. The elevated portion of this subregion, as Monte Regina, has great affinities with the Mediterranean region.

4) The *subregion Beira Baixa* consists of all the elevations together with the intervening valleys to the north of the basin of the Tagus and to the east of the affluents Niza of the Tagus, and Caia of the Guadiana. Its western frontier is formed by the Serra of Estrela. It is the most important portion of Portugal from the point of view of the climates of altitudes. The typical climates of the subregion are represented by San Fiel, Guarda, and Poio Negro in the Serra of Estrela. San Fiel, 516^{m} high, has a mean annual temperature

and humidity, and mean rainfall in winter, less than at Lisbon by $0^{\circ}.42$, 12.0 p. c. and $5^{mm.}$, respectively. Guarda, $1{,}030^{m}$, has a temperature and a relative humidity lower than those at Lisbon by $4^{\circ}.3$ and 3.3 p. c.; the rainfall in winter being somewhat more. Poio Negro, 1386^{m}, has a temperature lower by $7^{\circ}.17$, the relative humidity slightly lower, and the rainfall in winter very considerably more. The highlands of the district of Portalegre, to the south of the Tagus, also belong, from the climatic point of view, to this subregion.

5) The *subregion Eastern Estremadura* is formed by the basin of Tagus, being bounded on the north and the east by all the highlands, and on the south by the S. Continental region, with which it has a great resemblance. Tancos, towards the northern boundary, lat. $29^{\circ}38'$, at an altitude of $83^{m.}$, and at a distance from the sea of $70^{km.}$, has a temperature in January $2^{\circ}.5$ less than that of Lisbon, and in July about the same. At Vendas Novas, towards the southern boundary and $65^{km.}$ in a direct line from the sea, the mean temperature in January is $0^{\circ}5$ lower than in Lisbon.

The Northern Estremadura is characterised by the Lusitanian oak *(Quercus lusitanica)*; the Central, by a mixture of the marine pine *(Pinus Pinaster)* and the stone pine *(Pinus Pinea)*; the Southern, by the cork tree *(Quercus Suber)*; Beira Baixa, by the Beira oak *(Q. toza)*; and the Eastern Estremadura, by the cork tree *(Q. Suber)*. The northern side of the Serra of Cintra is characterised by the sycamore *(Acer pseudo-Platanus)* and the Lusitanian prune *(Prunus lusitanica)*; and the southern side of the Serra of Arrábida by the

dwarf palm (*Chamaerops humilis*) and the carob (*Ceratonia Siliqua*).

III) THE MEDITERRANEAN REGION.

The main annual, winter, and summer climatic factors of this region are:

	An.	Wt.	Sm.
Prevalent winds	S., S. E.	N., S. E.	N., S. E.
Temperature	17°.21	12°.38	22°.09
Yearly fluctuation	12°.21	—	—
Diurnal range	10°.20	8°.53	11°.72
Extreme range	25°.4	19°.7	22°.0
Relative humidity	66.6	75.0	59.4
Rainfall. mm.	478	181	20
Mean number of days of rainfall.	57	21	3

In this region the sea and the mountain breezes are well developed. Its littoral zone is divided by Sr. Baldaque da Silva (1) into three parts: the western, the central, and the eastern. The western, or the portion comprised between Cape St. Vincent and Albufeira, is of great interest. It is sheltered on the north by the Espinhaço do Cão and the Serra of Monchique. It is fully exposed to the sea-winds and breezes. Portimão, towards the west, has a climate similar to that of Lagos; Caldas de Monchique, 250 m. high, and 18 km. from the sea, has in winter a temperature 0°.38 lower and in summer nearly 1° higher than Lagos; and Sagres, towards the east, has a mean temperature in January the same as at Lagos. The central part, from Albufeira to Tavira, has the warmest littoral climate in Portugal. The mean tem-

perature at Faro is $0^{\circ}.5$ higher than that at Lagos. The eastern part, or that lying between Tavira and the estuary of the Guadiana, is not sheltered from the N. winds, and its climate is more variable than that of the two other parts.

The distinctive tree of this region is the carob *(Ceratonia siliqua).*

Some authors consider the climate on the coast of Algarve superior to that of the coast of the district of Lisbon. The climate is no doubt warmer by about $1.^{0}$ degree, but it is neither so constant nor so equable.

The characters of the climate of the *marine section* considered as a whole are: an equable temperature, with a cool spring and a warm autumn, the seasonal changes being moderate; the relative humidity is more uniform, but the amount of cloudiness and rainfall, and the force of winds are greater than in the continental section.

3. THE CONTINENTAL SECTION OR THE PORTION OF THE COUNTRY MAINLY UNDER THE INFLUENCE OF LAND WINDS: ITS REGIONS AND SUBREGIONS.

The continental section of Portugal is not, as regards climate, of as much importance as the marine. It consists of 2 *regions:* the N. Continental or the Transmontane, and the S. Continental or the Transtagan. The climate of the former is represented by Moncorvo, and of the latter by Beja. It has to be remembered, however, that Moncorvo is not a good representative of the N. Continental region, for it is situated in a hollow although at an elevation of 415^{m}.

The N. Continental region consists mainly of a

plateau, and the S. Continental of a high plain. Both these regions are subject mainly to land winds, or winds which have lost their normal humidity. In the N. Continental region the S.W. winds discharge their oceanic or marine elements on the western side of the Serra of Marão, and on the southern side of the Serra of Montemuro, so that the climate on the lee-side of both these mountains is continental. In a similar way, the N. winds deposit whatever extra humidity they may contain on the northern sides of the Serras of Cintra and Monte Junto, and in those of Arrábida and Ossa, so that when they reach the S. Continental region they are quite dry. In both the regions the marine winds pass at a high level from the ground. In the N. Continental they strike the Spanish frontier; and in the S. Continental they impinge upon the elevations of the subregion Beira.

I) THE N. CONTINENTAL REGION.

The annual, winter, and summer climatic factors of this region are:

	An.	Wi.	Sm.
Prevalent winds....	N. E., Calm	E., Calm	N. E., Calm
Temperature	15°.29	6°.69	24°.31
Yearly fluctuation	20°.8	—	—
Diurnal range.............	5°.8	3°.41	6°.05
Extreme range............. ...	13°.3	1 °.16	14°.9
Relative humidity.....	68.8	87.7	50.0
Rainfall .... .mm.	529	173	61
Mean number of days of rainfall..	128	40	16

This region consists of 2 *subregions:* the Northern Transmontane and the Southern Transmontane.

1) The *subregion Northern Transmontane* is bound on the west by the Serra of Marão and on the south by the various mountains which enter into the formation of the northern boundary of the valley of the Douro. It consists mainly of plateaus, and of the elevations which enter into the formation of the valleys of the Corgo, the Tua and the Sabor. In this subregion the mountains run from north to south, so that the mountain and the valley breezes are well developed; and there are also in favorable situations well developed intermountain breezes specially in summer (Ch. IV. 4).

2) The *subregion Southern Transmontane,* commonly known as *região vinhateira,* or the vine country, consists of the valley of the Douro beyond the southern extremity of the Serra of Marão. It is very hot in summer and very cold in winter; it has the reputation of having *nove mezes de inverno e tres de inferno,* or «nine months of winter and three of hell». Lobrigos forms a type of this valley; its mean temperature is $7^{0}.70$ higher than that of Moncorvo, and $8^{0}.68$ higher than that of Oporto. As the mountains forming the valley run from east to west, there are no intermountain breezes.

The Northern Transmontane subregion is characterised by the common oak *(Quercus Robur)* and by the chestnut *(Castanea vulgaris);* and the Southern Transmontane by the olive, the fig and the peculiar type of grapes yielding port-wine.

II) The South Continental Region.

The climatic characters of this region are:

	An.	Wt.	Sm.
Prevalent winds	N., N. W.	N.W., E.	N.W., W.
Temperature	15°.78	9°.53	22°.54
Yearly flctuation	15°.11	—	—
Diurnal range....	10°.22	7°.24	14°.35
Extreme range..............	20°.6	15°.2	26°.0
Evaporation .... mm.	2214	183	1036
Relative humidity	64.4	77°.8	49.3
Rainfall .... mm.	594	207	26
Mean number of days of rainfall .	111	39	8
Velocity of winds . ...km.	12	11	12

This region consists, also, of 2 *subregions:* the Western Transtagan and the Eastern Transtagan.

1) The *subregion Western Transtagan* is separated from the Eastern by the ridge which divides the basin of the Sado from that of the Guadiana. It slopes westward and is exposed more to the influence of the sea-breezes, and of sea-winds, when they are low level. Evora, situated near the northern frontier of this subregion, has at 15 o'clock a mean temperature of 2°.35 higher than that at Beja, and a higher relative humidity at the same time by 25.7 p. c. This is due to its proximity to the Serra of Ossa, and consequently to the greater influence of the S. W. winds.

2) The *subregion Eastern Trantagan* slopes towards the valley of the Guadiana, and is consequently exposed more to the land winds proceeding from the east. Campo Maior, situated nearly at its northern boundary,

has one of the most intense types of the Portuguese continental climate; its mean maxima are $1^{\circ}.45$ higher, and its mean minima $0^{\circ}.56$ lower, than those of Beja. Vila Fernando, to the west of Campo Maior, has a temperature lower than that of Beja by $1.^{\circ}16$ in winter, and higher by $1.^{\circ}96$ in summer, the total rainfall being 625^{mm}.

The vegetation of the Western subregion is characterised by the greater prevalence of the cork tree *(Quercus Suber);* and of the eastern, by that of the holm oak *(Q. Ilex).*

The *continental section,* considered as a whole, has a variable or severe climate, with a warm spring and a cool autumn, the seasonal changes being greater than in the marine section. The air is drier, and the rainfall is less.

4. CLIMATES OF ALTITUDES, FORESTS, AND CITIES.

All mountains, all forests, and all cities have each some distinctive climatic characters, in addition to the general characters of one of the four sections in which they are placed. Besides these three *sub-classes* classes, a climate based upon geographical features may be *lacustrine, riparian*, or *marshy*, under the influence of a large lake, river, or marsh, respectively. Most of the sub-classes owe their special climate to breezes.

The distinctive characters of a climate of *altitude* are: low pressure; comparatively cool in summer and warm in winter, and very cold in shade; dry in summer and very dry in winter; annual fluctuation and diurnal range either low or excessive according to exposure; little rain in winter above very high alti-

tudes; winds calm in winter and strong in summer; insolation intense and so also radiation when the ground is covered with snow; the air is clear, pure, charged with a good deal of ozone, and free from organic dust.

Each mountain has its peculiar climate according to its configuration or exposure. In the N. Atlantic and the Lusitanian regions, those mountains which are directed N.E. to S.W. have both their sides exposed, more or less, to sea-winds, and those which run from N. to S. are exposed to sea-winds only on the western side; whereas those which run from E. to W. are exposed to marine influence only on the southern side in the N. Atlantic and the Mediterranean regions, and, more or less, on both the sides in the Lusitanian region.

A mountain can be divided into different *zones*. It has been already pointed out how the vegetation in the Serras of Estrela and Gerez vary according to different altitudes (Ch. VIII. 2). Another instance of the same kind is given by Souza Telles, who divides the altitudes of Traz-os-Montes into 3 zones: the low or the hot characterised by the olive and the wheat; the medium or the temperate, characterised by the vine and the olive; and the cold, by the rye and potato (1).

A plateau forms a connecting link between mountains and plains. Compared with a mountain of the same elevation, it has a higher pressure and temperature, a higher fluctuation and a greater diurnal range; the relative humidity, and the amount of rainfall, clouds, and mists are less; and the insolation is not so strong. In winter clear crisp days are followed by cold and calm nights; and in summer calm nights are followed

by hot days, with occasional thunderstorms with some rain towards the afternoon. The best specimens of such climates are furnished by the N. Continental region.

The climate *of forests* or the *sylvan* climate, as compared with open spaces under the same geographical conditions, are cooler, more constant and more equable; the relative humidity, rainfall, soil moisture, and the amount of mist are greater; the velocity of winds is less, and so also the amount of sunshine; and the air may be charged with special aromas, rendering the climate *balsamic*. Bussaco, Cintra, and Bom Jesus do Monte owe their main characters of climates chiefly to their woods. The climates of forests are of exceptional interest, for they are more under the control of man. The non-sylvan climate is, generally speaking, the reverse of the sylvan.

The climates of *cities* and of habitations in general depend upon the way in which they are planned. Compared with an open space the climate of a city is, as a rule, warmer, the relative humidity is lower, and the winds are more moderate, but the air is charged with various impurities.

5. CLASSIFICATION OF THE MAIN SPECIES AND TYPES OF CLIMATES IN THE FIVE REGIONS. THE «PORTUGUESE CLIMATE» OF MARTONNE. THE WESTERN COAST OF PORTUGAL PRESENTS THE MOST TEMPERATE, COMBINED WITH THE MOST CONSTANT, AND THE MOST EQUABLE, CLIMATE OF THE WHOLE CONTINENT.

The main mean annual, winter, and summer climatic features of the five climatic regions, described numeri-

cally in the tables of the last two sections, may be classified according to their descriptive characters as follows:

Annual	I. N. Atlantic R.	II. Lusitanian R.	III. Mediterranean R.	IV. N. Continental R.	V. S. Continental R.
Prevalent winds	S.W.,S.,N.	N., N.W., in plains, and S.W. in highlands	N., S.E.	Calm, N.E.	N., N.W.
Temperature	Temperate	Warm	Warm	Warm	Warm.
Fluctuation	Moderate	Moderate	Moderate	Excessive	High
Evaporation	Moderate	Moderate	—	—	Excessive
Relative humidity	Moderately Moist	Dry	Dry	Dry	Dry
Rain: amount and frequency	Excessive, very frequent	Moderate, frequent	Very moderate, rare	Moderate, frequent	Moderate, frequent
Velocity of winds	Moderate	Moderate	—	—	Moderate

Winter	I.	II.	III.	IV.	V.
Prevalent winds in January	S.E., E.	N., N.E.	N., S.E.	Calm, E.	N.W., E.
Temperature	Cold	Temperate	Temperate	Cold	Cold
Range	Equable	Very Equable	Equable	Very Equable	Equable
Evaporation	Moderate	Feeble	—	—	Moderate
Relative humidity	Moist	Dry	Moderately dry	Moist	Moderately Hoist
Rain: amount and frequency	Excessive, rare.	Very moderate, rare.	Very moderate, very rare	Very moderate, rare	Very moderate, rare
Velocity of winds	Moderate	Moderate	—	—	Weak
Sunshine in December	ample (123 hrs.)	ample (131 hrs.)	ample	ample	ample

Summer	I.	II.	III.	IV.	V.
Prevalent winds in July.	N.W., W.	N W., W.	N., S.E.	Calm, N.E.	N., N.W.
Temperature...........	Warm	Hot	Hot	Hot	Hot
Range	Equable	Equable	Moderately equable	Moderately equable	Variable
Evaporation	Feeble	Moderate	—	—	Excessive
Relative humidity.......	Moderately dry	Very dry	Very dry	Very dry	Very dry
Rain: amount, and frequency	Scanty, very rare	Very scanty, very rare	Very scanty, very rare	Very scanty, very rare	Very scanty, very rare
Velocity of winds......	Moderate	Moderate	—	—	Moderate

The exact meaning of the terms used in these tables is to be seen in the sections of classifications of the various factors of climates. The prevalence of winds in each region is based more upon the distribution of pressure in general than upon the observation at a particular station.

As already stated, it is not possible or convenient to frame species of climates by taking all the factors of climates into account. For practical purposes, the species of a climate may be said to depend mainly upon temperature and humidity. Adopting these two factors as the basis, the *main species* of the seasonal climates in the five regions are six: cold and moist; cold and moderately moist; temperate and moderately dry; temperate and dry; warm and moderately dry; and hot and dry.

These six species do not represent all the climates in Portugal. They do not include, for instance, a cold and moderately moist, or a cold and moderately dry, species, which as a matter of fact, exist in high altitudes in spring and in autumn. Also the species of climate

in winter or in summer, as represented in the tables as regards a particular region, does not represent all the species which exist in that region. Cintra, for instance, only half an hour's distance by rail to the north-west of Lisbon, has all the main climatic characters of the N. Atlantic region; and Monte Regina, at one hour's distance to the south-east, has all the climatic characters of the Mediterranean region.

It is the *typical* characters that distinguish more one species of climate from another; and it is upon the typical characters that depend greatly the uses of a health resort. It is needless to say that it is more easy to specify the typical characters of a health resort than that of a large region.

The characters of the annual climate of a region or of a place are of importance to the inhabitants of the region, but not so much to an invalid in search of a good climate. In case of invalids, the seasonal climates are of more importance, for a climate may be, and often is, very favourable in one season and not in another. Generally speaking, there is no place in which at least one season is not more or less agreeable.

The duration of seasons varies in different parts of the country. In Lisbon or in the plains of the Lusitanian region, the winter and the summer consist according to Franzini, of four months each, from December to March, and from June to September, respectively; and spring and autumn of two months each, April and May, and October and November (1). From the phenological point of view, Lisbon and its environs consist of two springs of nine months, from October to June, and of a summer consisting of the three remaining months (Ch. VIII. 3).

M. Martonne, in his description of climates, says: «On the Coast of the Atlantic Ocean and in all the Northern portion of the Mediterranean Sea, the thermal amplitude is low; the commencement of rain is early and the fall is abundant. The month with the greatest amount of rain is frequently October (Provence and Central Italy). This kind of climate may be styled the *Portuguese climate* (type Lisbon), although the best type is the Archipelago of the Azores (2).

Generaly speaking, the nature of the climate described by M. Martonne belongs to the Mediterranean region of Portugal. The Western Coast of Portugal, especially in the Lusitanian region, has a climate which is quite distinct from all the southern portions of Spain, France, and Italy.

The western Coast of Portugal presents *the most temperate, combined with the most constant, and the most equable, climate of the whole of the Continent.* It has been pointed out (Ch. VI. 9) that Lisbon lies in the isotherm 15°, which is the most temperate temperature. Proceeding northwards, the isotherm 14° passes not far from the south of Oporto, and proceeding southwards, the isotherm 16° passes through the north of Lagos, so that nearly the whole of the western coast of Portugal lies in the most temperate portion of the western coast of Europe. It has, also, been pointed out (Ch. VI. 9) that there is no place in Europe, both in the parallel of latitude and in the isotherm 15°, which has a more equable climate than Lisbon. And, it may be further asserted that there is, likewise, no place in Europe in or between the isotherms 14° and 16° which has as equable a climate as that of any corresponding place in Portugal. This privileged condition of the country is due primarly

to the regional winds, and secondarily to the influence of these winds upon the Gulf Stream.

6. THE INFLUENCE OF CLIMATES UPON MAN, AND MAN'S INFLUENCE UPON THE MODIFICATION OF CLIMATE.

The influence of climates upon man may be considered under three aspects: physiological, pathological and therapeutic. The next three chapters will be devoted to each of these subjects.

Man cannot change or modify the cosmic forces of nature, but he can modify to some extent the medical climate, especially in the strata just above the ground:

a) He cannot raise to any appreciable extent the altitudes, but he can make some small cuttings;

b) He can modify, and has modified, the marshy soils by suitable drainage, and thus influence to some extent the humidity of the air and the temperature;

c) He can irrigate dry and barren lands, and thus increase to a slight extent the moisture in the air and decrease correspondingly the temperature;

d) He can plant trees in suitable localities, and thus break the force of the winds and change their direction;

e) He can increase the vegetation where it is rare or absent, and so increase the moisture in the air, and to some extent the rainfall;

f) He can prevent the pollution of the air in cities and towns;

g) And he can select suitable sites for habitations, and lay them out scientifically, so as to utilise all the favourable factors of climate, and to avoid the unfavourable ones.

The climate of the whole of Portugal could be

modified by extending the cultivation, in suitable soils, of the marine and the stone pines; by planting the Aleppo pine *(Pinus halepensis)* on the plains with lime soils, from the valley of the Mondego to the shores of Algarve; by planting the larch *(Pinus laricis)* in granitic soils, in altitudes from 700 to 1000^m; and by extending the cultivation of the indigenous red pine or the Scotch fir *(Pinus sylvestris)* in altitudes over 1000^m.

There is great room for many of these improvements in several parts of the country.

7. DOES PORTUGAL FORM A CLIMATIC UNIT? AND HAS ITS CLIMATE CHANGED DURING THE HISTORICAL PERIOD?

Compared with the tableland of the Iberian Peninsula, Portugal forms a *distinct climatic unit*. The greatest factors, which contribute to give it its characteristic features are: first, the geographical configuration; and secondly, the influence of the Gulf Stream and of the sea.

Portugal, as a whole, forms the Western Inclined Plain of Spain exposed to the marine weather side, whereas the portion contiguous to it in Spain forms a plateau, the climates of the two being quite distinctive. The extreme north of the country has a climatic resemblance with the south of England and of Ireland; and the extreme south has a resemblance with the northern shores of Morocco; whereas the Lusitanian region has a distinctive and quite characteristic climate of its own. Portugal receives the influence of the Gulf Stream at first hand, or in its purest and warmest condition. This renders the climate the most equable

of all the others on the continent, especially in winter. The distinctive features of the Portuguese climate are confirmed by its characteristic flora.

Dr. Rochard, in describing what he considers to be the most favoured climatic region of Europe, says: «It is in 45° degrees N. lat., or at an equal distance from the equator and the pole, that the year presents its seasons with their classic characters. The temperate zone *par excellence* is the parallel of Bordeaux, Grenoble, Valence, Turin, Plaisance, Mentone and Venice. This is the most favoured portion of the globe. In proceeding northwards the winter is more severe, and the spring becomes cold and short; in proceeding southwards of Europe the winter lasts very long and is followed without any transition by a short and burning summer, which gives rise to a prodigious rapidity of vegetation, followed soon by rain, mist and winter» (1). Astronomically considered, there is no doubt that Dr. Rochard is quite right, but physically or medically considered, it is quite different. Owing to the differences in the geographical features, and to the disposition of the pressure and winds the centre of the physical or the medical climate on the western coast of Europe is not in the latitude of Bordeaux but in that of Lisbon (Ch. VIII. 7). The mean temperature of Bordeaux is 13°.6 or 1°.4 less than the mean of the earth or of Lisbon.

Has the climate of Portugal changed during the historical period? The answer depends upon a wider question: Has the climate of any other country in Europe, or of Europe itself, changed during the last 2500 years? Some writers are of opinion that there has been a progressive change, but the generally

accepted opinion is that there has been no change, and that if there has been any it is almost imperceptible.

As regards Portugal, there is a vague idea that the conditions of the climate during the domination of the Romans and of the Moors were, at least to the *south* of the valley of the Tagus, and specially in the province of Alemtejo, much more favourable to agriculture than they are now. This idea is, no doubt, due to the Greek, Roman and the Moorish authors, such as Polybius (2), Justinus (3), and Aboulfeda (4), who describe in very laudatory terms the great fertility of Lusitania.

There is some evidence in one of the works of Appianus Alexandrinus (5), that the country around Evora, specially in the II. century, was well wooded and well cultivated. And, according to Herculano, in the XII. century «Alcacer do Sal was surrounded on all sides by extensive pine forests, and that the timber which they yielded was one of the principal articles of export» (6). These and similar conditions might have modified the local climate. Moreover, cultivation depends often upon the amount of security of life and property, and upon the profit it yields. The province of Alemtejo is immensely more productive now than it was two hundred years ago. The three districts of Portalegre, Evora, and Beja produce at present more wheat than 13 other districts which have double the area. It is not so much the climate as the insecurity of life, combined with the economic laws, which gave rise to a state of semi-desolation of Alemtejo in the XVIII. and at the commencement of the XIX. century. But even in the XVIII. century it had, according to

Dr. Saldanha, «a great abundance of wheat, barley and legumes» (7).

As a matter of fact. the agriculture of the country flourished in the time of the Romans; it decayed absolutely during the domination of the Barbarians; it flourished again from the XIV. to the XVI. century, or from the reign of D. Deniz to that of D. Manuel; then it fell once more into decay, to rise again from the middle of the XVIII. century, at first slowly, and then, during the last 50 years, very rapidly. The second decline commenced with the expedition to Africa and followed the discoveries and conquests in Asia, America and Oceania.

If some of the statements of some modern writers are to be trusted, it would appear that there has been a considerable change of climate to the *north* of the valley of the Tagus. Richard Twiss, a Fellow of the Royal Society, in describing the Serra of Estrela in 1772, says that its «summits are always covered with snow» (8). And Balbi makes in 1822 a similar remark as regards the peaks to the north of Bragança and to the north of the river Lima (9). It is now known, for a good many years, that there is no peak in continental Portugal covered with snow throughout the year. It is much more probable, nay certain, that the description given by the two authors, and some Portuguese writers, such as Dr. Sanches (10), is inaccurate, than that the climate has changed during 100 to 150 years.

In support of the opinion that there has been no change in the climate during the historical period, there are two documents of exceptional interest.

The first is the rural calendar framed by Columella (11) in the I. century to guide his steward in the

management of the property which he had at Gades (Cadix). He makes some meteorological observations, and gives directions as to the time of the sowing of beans and wheat, and of planting fruit trees and for grafting. Here are some of his dates. The winter commences on the 9th November. The 13th January is the best time for grafting cherries, almonds and peaches. On 18th February the quails make their appearance; and from the 21st to 28th, the swallows. From the 1st to 20th March is the best time for the grafting of vines. The harvest of the barley is on the 13th June. And the best time for planting all shrubs and fruit trees is from 15th to 30th October.

And the second is the rural calendar for Cordova, written by Harib, bishop, son of Zeid (12), in the X. century, who likewise gives his observations regarding the meteorological, vegetable and other phenomena. He notices that the narcissus commences to flower on the 1st November, and the early almonds on the 1st December; and that the swallows arrive at the end of February, and the quails at the commencement of March. He also gives the best period for the grafting of the apple trees and the figs.

If these and several other observations, contained in the two calendars, be compared with those of the present day, it is seen that they hold just as good now as they did in the I. and the X. centuries. And if there has been no change in the climate of Andalusia, it may be assumed that there has been likewise no change in the contiguous Portuguese provinces of Algarve and Alemtejo.

To the facts mentioned above may be added the most interesting observation, already quoted, of Poly-

bius, that in Lusitania, in the II. century B. C., the roses, the lilies, the asparagus, and other similar flowers were absent then, as they are now, only during 3 months of the year.

As additional proofs of the view that there has been no change of climate in recent periods, it could be shown that there has been no change in the type of diseases as described by writers in the XVI. century; and that the types of some of the vintages in the north are just the same today as they were in 1693, or even earlier.

When all these facts are taken into consideration, it may be concluded that in the whole of Portugal there has been no perceptible change of climate during the historical period. It is possible that the forest modified locally, and to some extent beneficially, the climate of Alemtejo in olden times.

Brüchner has shown that there is a cyclic change of weather every 35 years. This subject has a great interest to the medical profession, for it has an important bearing upon public health, as in the prevalence of typhus and other diseases (13).

8. ON THE FORECAST OF WEATHER: SCIENTIFIC AND POPULAR. METEOROLOGICAL REPORTS IN THE DAILY PRESS.

The question of the forecast of weather, at long or at short periods, may be looked at from the scientific and from the popular points of view.

The *scientific* forecast of weather at long periods, if feasible, would be extremely useful to invalids. This study is at present based upon the observation of

typical storms and of typical abnormal variations of weather, for it is certain that even abnormal weather has its laws.

In 1880, Blanford showed that there is a barometric sea-saw between Russia and Siberia on the one hand, and the Indo-Malay region on the other (1); or, in other words, that the position of centres of high and low pressure has more or less a definite relation with climatological characters.

In 1883, M. de Bort (2) pointed out that the study of the «centres of action», or of high and low pressures, especially those of Madeira and the Azores on the one hand, and those in Iceland, the Bermudas, and Central Siberia on the other, might lead to the prediction of the kind of season which may be expected in Portugal and in Western Europe. A very low pressure in the south of Iceland leads to a mild winter in the north-west of Europe; whereas a very high pressure in the Azores and in Asia gives rise to severe winters.

And, lastly, Hildebrandsson (3) has shown that the quantity of rain which falls during winter in different years at the Azores and in Iceland are always in inverse ratio.

The great factor which determines the nature of weather in Portugal is the Gulf Stream, which plays an important influence directly upon the coast, and indirectly by the different changes in pressures it gives rise to in Iceland.

The study of pressure and winds is also of use in determining the weather in the past, for, in truth, says Buchan «it is only by the aid of this principle that any rational attempt based on causes having a

purely terrestrial origin, can be made of those glacial and warm geological epochs through which the climates of Britain and other countries have passed» (4).

If a bit of speculation be permitted, it may be asked whether it is not possible, nay probable, that the great centres of action, of atmospheric pressure as they exist now, had not in the remote past their share in the formation and configuration of the coast between Caminha and Espinho, from Espinho to Cape Carvoeiro, and from Cape Sines to Cape St. Vincent (Ch. II. 1).

The scientific forecast of weather at short periods is also based upon pressure. Admiral Fitzroy was one of the earliest writers to initiate this study (5). All know that a fall in barometer indicates bad weather and a rise indicates fair weather. Unfortunately these indications do not always hold good. Under certain circumstances a sudden fall means good weather, and a sudden rise the reverse. A gradual rise or a gradual fall afford safer indications. The direction of the winds combined with the hygrometre affords surer means for the prevision of weather at a particular place. One of the most important among the recent studies on this subject is due to Guilbert (6).

In all countries there are *popular* aphorisms and signs for the forecast of weather at long or at short periods. It is needless to say they do not often correspond with realities.

As regards *long* periods the following maxims are of interest:

Por Natal ao jogo,
Por Pascoa ao fogo.

Christmas in the green,
Easter behind the screen.

Quando a Candelária chora,
O inverno está fora;
Quando a Candelária ri,
O inverno está ainda por vir.

If Candlemas Day be clouds and rain,
Winter is gone and will not come again;
But if Candlemas Day be clear and bright,
Winter'll have another flight.

Como vires a primavera,
Pelo al espera.

Spring cloudy, summer sunny,
Spring sunny, summer cloudy.

Maio pardo,
Junho claro.

May grey,
June gay.

Lua nova trovejada,
Trinta dias é molhada.

If new moon's day be rainy weather,
It will rain for thirty days together.

The best weather which may occur in winter and spring in any year is expressed thus:

Janeiro gioso,
Fevereiro nevoso,
Março molhinoso,
Abril chuvoso,
Maio ventoso,
Fazem o ano formoso.

January frosty,
February snowy,
March misty,
April rainy,
May windy,
Make a year lovely.

The prediction of weather at *short* periods is based upon various natural phenomena, such as the halo of the sun; the crown of the sun and the moon; the clearness of the air, so that the moon and the scintillations of the stars may be seen clearly during the night, and the contours of distant hills during the day; the form and the colour of the clouds; the condition of the sea as regards tides and waves; the direction and nature of winds; the hygroscopic condition of the air giving rise to many phenomena in organic and inorganic objects; and to the degree of heat. It is not of much use to describe here all these signs and their indications. Those who are interested in the subject will find much useful information in Dr. Bleunard's art of predicting weather (7).

The *meteorological reports* in the daily papers in Lisbon are often very deficient in information. It would be useful if they would insert the excellent barometrical charts published every day by the Observatory in Lisbon. In reporting the daily temperature, it is necessary to know by how many degrees it was higher or lower than the mean of a number of years for that day. And as regards rainfall, it is not enough to register the number of millimetres every day, it is necessary to state whether the total up to date is higher or lower than the mean total, and whether the distribution is regular. This information is specially necessary for agricultural purposes. In fact, it would be very useful if each meteorological station would publish such information for the benefit of the local farmers.

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CHAPTER X.

THE INFLUENCE OF THE CLIMATE UPON THE PHYSIOLOGICAL OR THE VITAL FUNCTIONS OF THE BODY AND MIND.

The happiness of a man proceeds always from his individual good fortune, but it depends likewise upon the climate, upon his organisation and temperament, and upon his traditions.

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I. THE FOUR MAIN CAUSES WHICH MODIFY THE VITAL FUNCTIONS.

Just as a climate impresses certain characters upon plants, and certain plants reveal the nature of a climate, in a similar manner, but in a very considerably lesser degree, a climate impresses upon men certain special characters, and the special characters form an index to the nature of the climate. The physiological effects of climate are more noticeable in plants than in men, for plants are fixed, whereas man, by his intelligence and will, is capable of adapting himself to any new environment in which he may be placed.

This chapter will be devoted to the influence of the climate upon the physical, moral, and intellectual development of the Portuguese in general. The influences of the climate upon special organs, or upon the circulatory, respiratory, digestive and other systems, will be described under Chapter XIII., for they have an intimate connection with treatment.

Man is of all sensitive beings the most susceptible to sensations of pleasure and pain; and the climate contributes its share to increase or décrease both the sensations.

The main causes which determine the physical and moral development of different races have been admirably indicated by Hippocrates in the following passage: «There are in Europe other *tribes* differing from one another in stature, shape, and courage. . . Such as inhabit a *country* which is mountainous, rugged, elevated and well watered, and where the changes of *seasons* are very great, are likely to have great variety of shapes among them, and to be naturally of an enterprising and warlike disposition; and such persons are apt to have no little of the savage and ferocious in their nature; but such as dwell in places low lying, abounding in meadows and ill ventilated, and who have a larger proportion of hot than of cold winds, and who make use of warm waters, — these are not likely to be of large structure nor well proportioned, but are of a broad make, fleshy, and have black hair; and they are rather of a dark than of a light complexion, and are less likely to be phlegmatic than bilious: courage and laborious enterprise are not naturally in them, but may be engendered in them by means of their *institutions*» (1).

From the words placed in italics it is clear that the

main causes of the physical and moral development of man are *four* in number: race, geographical or physical features of a country, climate as modified by winds, and institutions. If all these be favourable, they give rise to full physical development, to health, energy and vigour, to longevity, and ultimately to natural decay and natural death. A good physical development is accompanied, as a rule, by intellectual capacity and moral vigour. Broadly speaking, the race determines the physique and certain moral and intellectual capacities; the soil and the aspect of the country contribute to the quality of food and to esthetics; the climate and the food influence the constitution and the temperament; and the institutions control the formation of the character. The relations between all these physical agents upon the human economy are infinite; and just as there are infinite variations of climates, so there are infinite degrees in the physical and moral development, not only among different races, but also among individuals of one and the same race.

From the scientific point of view, it is Buffon, Lamarck, Darwin, and Spencer, who have established upon a secure basis the following facts: a change of environments, whether climatic or others, gives rise to different needs; different needs demand different actions; different actions produce different habits; different habits originate different structures; different structures bring about different capacities; and different capacities in men, in their turn, produce different civilisations. «And obscure as is», says Darwin, «the problem of the advancement of civilisation, we can at least see that a nation which produced, during a lengthened period, the greatest number of highly intellectual, energetic,

brave, patriotic and benevolent men, would generally prevail over the less favoured nations» (2).

It is not always easy to apportion to each cause the exact influence due to it. The food supply of a country, for instance, depends upon the nature of the soil, and the amount and distribution of rainfall; the actual crop depends upon the labour that is available; the price of the product depends upon the fiscal laws; and the consumption depends upon the richness or poverty of the people. The influences due to race and institutions do not, properly speaking, enter into the scope of this book, but a few remarks on these subjects are useful to render clear the influence of the climate.

The most perfect development of a man or a race depends upon a harmonious combination of many concurrent circumstances. There is no doubt that a good climate is one of them. There is no doubt, likewise, that the climate and all the local factors may be most favourable, and still there may be no progress, if the artificial environments or the institutions are not adapted to the local requirements.

No non-professional writer, both in the old and modern times, has described the influence of climate upon the physical and moral development of different nations more tersely, more lucidly, and more brilliantly, although, from the facts now known, not always quite accurately, than Montesquieu (3). And among English authors, Buckle deserves, in this respect, a very high place (4).

Unless otherwise stated, all the vital and social statistics are taken from the Census of 1911, kindly furnished by Sr. Agostinho Franco; and from the Annual Statistics (5). Care has been taken to avoid

the quotation of a large number of figures; and more attention has been paid to describe, as far as possible, the effects of the local conditions rather than those which are more or less common to all temperate climates.

2. INFLUENCE OF RACE.

No country in Europe has been overrun by so many different races as the Iberian Peninsula. The original inhabitants of the country or the Iberians are supposed to have belonged to the mongoloid race. The earliest foreigners of the Aryan race to settle in Portugal were, according to some authorities, the Ligurians; then followed the Celts or the Gauls, belonging to the Indo-Germanic family. The first civilised people to conquer it were the Phœnicians, who were followed by the Carthagenians in the III. century B. C. The Romans completed their occupation of the west of the peninsula during the reign of Augustus, and governed it till the first quarter fo the V. century. The Vandals, the Swevi and the Goths swept across the country from the year 417 onwards; and the Moors conquered it in 711, and retained it till the XIII. century.

After the establishment of the monarchy, the Crusaders brought in an influx of many French, Genoese, Lombards, English, Dutch and Germans. The great commercial prosperity at one period of the history gave rise to an immigration of a large number of Jews. There was, also, a considerable number of Jews in the Wisigothic period.

The various conquests in Asia, Africa, and America led to the introduction of slavery into the large towns, chiefly for domestic service. For about a hundred

years in the XVI. and XVII. Centuries Lisbon and Oporto had a considerable number of negro slaves. In 1551 they formed in Lisbon 9.95 per cent or 9,950 out of a total population of 100,595, and in 1620 their percentage was 6.3 (1). But this did not mean a wholesale or strong admixture of the slaves with the people of the country, as foreign writers, like Racinet (2), seem to imply. There was no more admixture between the slaves and the people of the country in Portugal than there was in other countries in Europe employing similar labour in former times, as England; and much less than in all other countries, under similar circumstances, in other parts of the world. This subject has been discussed in detail by Marquis de Sousa Holstein (3), and by Dr. Silva Amado (4), the former devoting his attention to the physical character, and the latter mainly to the historical origin or to the development of the race. Here, it is sufficient to mention two recent observations. Firstly, the nasal index of the Portuguese, according to Sr. Mello, is 49.69 (5); of the English, 46; of the Parisians, 46.7; and of the Italians of Lombardy, 48.3; whereas that of the negroes varies from 60.2 to 55.5. And, secondly, the alveolar index of the Portuguese, according to the figures kindly placed at my disposal by Dr. Tamagnini Barbosa, Professor of Anthropology at Coimbra, is 96.69, and of the English, 96.2, that of the negroes being 104.4. The observations on the nasal index were made under the supervision of Dr. Bernardino Machado, and those on the alveolar index are due to Assistant Prof. Dr. Barros e Cunha.

The great admixture of the Portuguese with the Negro is a legend similar to that of the rainfall

at Coimbra. Besides all the proofs adduced above, the following sociological law, which has not yet attracted any notice, deserves attention. When in any country, as in new colonies, the number of white men is far in excess of white women, the admixture of races in proportion to the white population, is great or very great. But when the number of white women is equal or superior to white men, then the admixture is extremely low or *nihil*. This law is based upon the fact that, in all countries and in all self-respecting females, the racial sentiment, specially when the colour is different, is much more developed than in men, for the simple reason that the maternity of a child can never be denied, whereas, in unmarried persons, the paternity remains always doubtful. In Portugal, during the slavery period, owing to the frequent military and naval expeditions, to a large emigration of able-bodied males, and to the large army of priests, the number of Portuguese women was far in excess of men, and, therefore, there was not, and there could not have been, much admixture between the two races.

When the slaves died out, there was a great influx of Spaniards from Gallicia.

At the present day the autochthonous and the Ligurian element is supposed to predominate in the North Atlantic and the North Continental regions; and the Moorish in the Mediterranean and the South Continental. In the Lusitanian region, especially in the district of Lisbon, there is an admixture of all the elements. There is a greater admixture of races along the coast below the valley of the Mondego than above it. According to Herculano, «it is difficult to establish any connection of common nationality between the

present Portuguese and the Lusitanians, or any other tribe or race that originally inhabited the country» (6). But although nationalities have disappeared still many customs and habits ramain, and blood tells. The old Lusitanians, who had two out of their three provinces located in modern Portugal, were, according to Strabo, an agile, nimble and a supple race; they were sober and drank usually water and rarely wine; they used butter in cooking their food instead of oil; they were the strongest nation in the Iberian Peninsula; they slept in hard beds made of straw; and their women danced with the men, each having a partner vis-à-vis, to whom they marked time with their hands (7). It is interesting to find that, with the exception of using butter in cooking their food, all the other characteristics are noticeable at the present day. The Ligurians, it is said, have bequeathed a highly developed sentiment of independence and patriotism, but no definite proofs are adduced in support of this statement. On the other hand, there is no doubt that the Phoenicians and the Carthagenians have left a spirit of maritime adventure; the Romans, their type of language, their main social and political institutions, and their discoveries of the mineral and thermal waters; the Moors, some of their social customs, such as the seclusion of women, their type of architecture, and their taste for mathematics and medical science; and the Crusaders, an enhanced spirit of chivalry and adventure.

Of all the foreign nations, it is the Romans who have left a distinctive impress of their civilisation, for they came from the same latitude and the same isotherms as Portugal, and were therefore, better able to acclimatise themselves than the other races which came

from the lower or the higher latitudes, and from different isotherms.

A celebrated physician of the XVI. century, Amatus Lusitanus, after describing the similarity of climate between Lisbon and Rome, notices the fact that the physiognomy of the inhabitants of the two cities is quite alike, and that the duration of life is much the same (8). One century later, another famous physician, Zacutus Lusitanus, also compares Lisbon, his *patria dulcissima,* with Rome, but finds that the duration of life is less in the former than in the latter, and attributes the fact to the lower latitude of Lisbon (9).

The Moors have left a less impress of their civilisation in Portugal than in the south of Spain, for they were expelled from the former country 200 years earlier.

The presence of slaves in large towns gave rise to a distaste for all domestic service, and menial work in general. Only a few years ago, a petty clerk would rather die than carry a handbag of papers to his office; and a common workman felt it debasing to fetch a jugfull of water from a neighbouring fountain for his own use. The Gallicians, who know better, have taken, and take even now, full advantage of this conceitedness.

The influence of the modern or contemporary nations will be described further on (§ 5).

Some sociologists believe that a great admixture of good races is favourable for the progress of a nation; and they attribute the rapid advances of various industries in the United States of America partly to the great variety of races and subraces to be found there. If this be tenable, Portugal presents, historically con-

sidered, an excellent racial element for the progress of the country.

Portugal as a whole is dolichocephalic.

3. INFLUENCE OF GEOGRAPHICAL OR PHYSICAL FEATURES.

The physical features of a country contribute their share to the physical, moral, and esthetic development of a race. The effects of the physical features cannot always be dissociated from those of the climate; and consequently they are incorporated with the influences of the various classes of climates in the next section.

The soil determines the nature of the crops and of vegetation. It determines also the nature of monuments and of habitations: in the granitic soils of the North Atlantic region there are no monuments comparable to those in the Lusitanian region, in which the soil consists of lias.

Mountainous countries are favourable to the development of the physique of their inhabitants.

All physical features which are beautiful are soothing, whereas those that are ugly are irritating. The charm of the Portuguese country, combined with the softness of the climate, has the effect of softening the manners and customs of the meanest of the inhabitants. The women are distinguished by their animated physiognomy, and by their sweet, timid, and gentle manners. Every nation praises the beauty and graces of its own women, but there is at least one British writer, Udal ap Rhys, who thinks that the Portuguese women are «infinitely the finest that Man can conceive» (1).

4. INFLUENCE OF THE DIFFERENT CLASSES AND SPECIES OF CLIMATE: EMIGRATION AND ACCLIMATISATION.

The immediate physiological effects of climate are not so important or decisive as the remote. A person who emigrates for the first time from a cold to a tropical country is surprised to find himself full of energy and vigour, but this does not last long, he soon finds out that he cannot do the same amount of work as in the cold climate. The best climate for the progressive development of man is the cold and the temperate. Different *classes of climates,* combined with the geographical features, impress different characters upon the people who reside permanently in them.

People residing in the zones bordering on the sea and subject to *marine* climate are more cosmopolitan, more tolerant, and more adventurous. Those who lead a sea-faring life are hardy, strong and somewhat superstitious. The wide expanse of water widens their sympathies, and inspires an adoration of nature. There are greater facilities for a higher type of civilisation in this zone than in places situated inland.

Those who reside in the *continental* section are more conservative than those in the marine, more soft in manners, and more polite to strangers. They are also more religious, provided they do not reside in large cities. Physically they are not very strong.

The inhabitants of *mountains* retain more the characters of the aboriginal races than those residing in the plains. They are very conservative, very hardy, strong and energetic; they are often more ignorant

and more superstitious, but they are more patriotic and more independent. A Greek classical writer notices the interesting fact that the inhabitants of the high portion of the city of Athens had a temperament different from those residing at the Port of Piraeus.

The dwellers in *forests* do not attain full size. The chronic insufficiency of food acts as a check to their physical development. They are also soft and shy.

Large *cities* are not favourable to physical development, but they lead to an alertness of certain mental faculties, and often to moral deterioration.

All the climatic characters, combined with other causes, fix the local type of a race, and in the long run this type prevails. The different *species* and *types* of climates give rise to different advantages and different defects in the physical, moral and intellectual faculties among different peoples.

1) The climate influences, directly or indirectly, many of the *physical* characteristics of a people, and their mode and manner of living.

Other conditions being the same, a cold climate, especially if it is dry, favours the development of a strong *constitution*. The people in the northern regions are more muscular, more active, and more capable of sustained effort, than those in the south: the cold climates do not favour the early development of the mental faculties and of some of the physical functions. It is for this reason that all the old civilisations proceed from the south towards the north.

If the history of only the Aryan people be examined it is seen at once that the Indo-Iranic branch was earlier to develop than the slavonic, the celtic or the germanic; and of the eastern branch the Indian

family was earlier to develop than the Heleno-Latin.

Unless modified by appropriate institutions, in proceeding to higher latitudes, or to a lower isotherm than 15°, there is, in a given race, a gradual predominance of the physical development over the spiritual, leading to movement and action; and in proceeding southwards, there is a gradual predominance of the spiritual over the physical, giving rise to lassitude and meditation; in the former there is a tendency to high living and low thinking, and in the latter to high thinking and low living; the former has discovered almost all the modern comforts of physical life, and also, unfortunately, all the weapons of physical destruction; the latter has produced almost all the high spiritual ideas and all the important philosophical systems; the former leads to optimism, ambition, greed, aggressiveness, and to the substitution of might for right, and the latter to pessimism, indifference, meekness, gentleness, and to the substitution of right for might. Fortunately, during the last 50 years, appropriate institutions are gradually and slowly modifying the characters of the former as well as of the latter.

All the conditions due to cold and warm climates are exemplified in a very limited degree in Portugal itself. The best and the greatest monuments of the Romans are found more in the south than in the north, which shows that in former times the south was more advanced than the north. Evora was much more important than Oporto, and Silves was ten times larger than Lisbon. But at present, number for number, the northerners have a greater preponderance than the southerners. It is from the north that has usually

proceeded the cry for independence and for liberty: the south is given more to abstraction and to meditation, to dreaming about the past, and to planning grandeurs for the future. The people of Oporto are more practical, persistent, and business-like; those of Lisbon are more flighty, more rhetorical, and more given to *laisser-faire*. The differences are well exemplified by the medical students of the two faculties. In Oporto they select for their theses subjects connected with their city and with the country; in Lisbon, they prefer to discuss theories, to take much less interest in subjects connected with their city or with the country. The northerners study more the natural history and physical sciences; the southerners devote themselves more to history and archeology.

Compared with the other Latin races, the features of a Portuguese are soft, sympathetic and very animated. He makes an excellent soldier, capable of enduring great privations and great fatigue, and also great heat and great cold.

The mean *height* of the adult population is $1^{m}645$. From the Douro to the Mondego it varies from $1^{m}67$ to $1^{m}70$, and to the north of the Douro and the south of the Tagus it varies from $1^{m}61$ to $1^{m}64$. The height is also under the influence of other causes than climate; it is low where the soil is poor and marshy, above certain altitudes, and at all places where there is great poverty. The mean heights of the other Latin races, according to Sr. Cardoso, are: the French $1^{m}659$, the Italian $1^{m}645$, and the Spanish $1^{m}635$ (1).

The climate is supposed to have some influence in the *colour of hair*, and of the *skin*. It has been esti-

mated that about 2 per cent of the Portuguese population have light or fair hair; 20 per cent have dark hair; and the remaining are made up of various tints of dark chestnut. The women are distinguished by the abundance of hair, and beautiful dark bright eyes. The skin has a more brownish tinge in the south than in the north.

The *puberty* is developed earlier in the hot and warm climates than in the cold and the temperate. In the latitude of Portugal the mean age at which girls attain their puberty is 14 years.

Climates affect likewise the *voice*. A cold and dry climate makes it soft and pleasant, while a hot and damp climate makes it harsh and hoarse. A fine climate like that of Portugal enables people to lead much outdoor life, which compels them to raise their voice to a higher pitch than those peoples who are compelled to remain more indoors. People near the coast also talk louder than those who reside inland. Owing to both these influences and, perhaps, to habit, even highly-educated and grey-haired persons in Portugal can bear noises which would be unbearable to northerners belonging to the same class of society.

Climates have an influence in regulating the nature and the amount of the consumption of *food* and *drink*. More animal food can be supported and is required in a cold than in a hot climate. In Lisbon the consumption of meat per head per year is 36^{kgm}, in Paris it is 60, and in London 80. The food of the Portuguese peasant consists chiefly of vegetables combined with a small quantity of fish or pork. He drinks usually wine, seldom any spirit, and never any beer. This makes him less corpulent than those who habitually drink

beer. The amount of food consumed is much more in the north than in the south; and more in winter than in summer. There is a natural tendency to consume more fruit, more vegatables, and more cereals in summer than in winter.

Due to the brightness of the climate, a love of show and grandeur pervades all classes of people. The peasants are very fond of bright and multi-coloured *dresses* with, if possible, numerous and large gold ornaments; and the rich display, ostentatiously, the latest fashions of Paris or London.

The external appearances of *houses* is gay; they are painted with colours of various hues, and sometimes covered with glazed tiles.

2) The influence of climates upon the *moral* character of a race is less evident than upon the physical. A pleasant and a bracing climate excites special emotions of the nervous systems. The temperament in a cold climate is, generally speaking, sanguine; in the hot it is bilious; and in the temperate it is more or less nervous, soft and mild. A bright and a clear climate, as in Portugal, leads to gaiety, to sentimentality, to poetry, to romance; whereas a dusky, foggy, and sombre climate leads to sadness, seriousness and reservedness.

There is a general belief, due greatly to the influence of Montesquieu, that the inhabitants of the southern or warmer countries are less strict in their social or sexual ethics than those of the northern or colder countries. As a matter of fact, the difference lies more in the purity of expression than in the practice of chastity. If Montesquieu's ideas were carried to their logical conclusion, there would hardly be a moral man or a

moral woman in the tropics. But such is not the case. There are just as moral communities in the tropics as in the temperate belt, and just as moral in the temperate as in the cold. The other factors which determine the morality in different races do not come within the scope of these pages.

A Portuguese is humble, tender-hearted, benevolent and honest; he is inclined to be very lenient to his friends, and very unjust to his adversaries.

3) The bright and the blue skies, combined with the mildness of the climate and the hereditary influences, tend to heighten the *intellectual* faculty of imagination of all the people, and to increase their sensibility. The literate classes are at present more careful of the form and of the beauty of expression than of the scrupulous correctness of facts. They gain in brilliancy and extent, and lose in depth and accuracy. There is a general tendency to exaggeration, so noticeable in the number of superlatives and diminutives used, both in conversation and in writing. The greatest ambition of every student is to become a poet or an orator. Almost every man of letters, and even of science, commences his career by composing verses. There is no country in which a poet is more honoured; and no country pays a higher homage to any of its national poets than Portugal does to Camoens. The facility with which some country-women compose verses is very remarkable.

A Portuguese, on the whole, is subjective and contemplative; he has a great intelligence and immense power of receptivity and imitation; he is fond more of arguing than of collecting facts. Under proper guidance and supervision he is an excellent workman.

«The climate, the nature of the soil and the other natural features of the country», says Professor José de Figueiredo (2), «have contributed to the formation of a distinctive Portuguese school of painting as represented by Nuno Gonçalves, which is quite different from the Spanish or that of Murillo, and from the Flemish or that of Van Eyck». The primitive Portuguese pictures «are soft and enveloped in sweetness and suavity», due to the softness of the humidity of the air, which contrasts on the one hand with the dryness of the air in Spain, and on the other hand with the dense mists in the Netherlands.

Architecture and sculpture have been more cultivated than painting. The taste for music is greatly developed among all classes of people. The popular song or the *fado* is usually very sentimental with a tinge of sadness. There is a great taste for mathematics and philosophy, and little inclination for practical or applied sciences. The arts receive more attention in the north than in the south. The great national failing is a love of novelties: novelties in science, novelties in politics, novelties in literature, novelties in dress.

Out of the *six main species* of the Portuguese climates, the most favourable to the development of the vital functions are the cool and moderately moist, and the temperate and dry; and the least favourable are the hot and dry, and the warm and moderately dry.

The most favourable climate for the middle-aged persons is the cold, for children the temperate, and for the old the warm. The most favourable season for healthy person is winter.

The Portuguese *emigrate* for two reasons; those from the northern regions more for the love of gain,

and those from the southern more on account of poverty.

The Portuguese bear well great cold and great heat, and *acclimatise* themselves in various parts of the world better than almost all the other European races. In the Napoleonic campaign in Russia, the Portuguese and other soldiers from the south of Europe were able to stand cold, according to Baron Larrey (3), better than those from the north, and produced less victims. In the warm and hot States of Brazil a large portion of the population is either Portuguese or of Portuguese origin. Among the causes which contribute to the easy acclimatisation are: the native climate, which is the most temperate of the whole of Europe; the sobriety of the emigrant, both in food and in drink; and the nervous temperament, which enables them to bear more fatigue and privations than the sanguine or bilious persons. The marine life led by some of the emigrants is also a good preparation for acclimatisation. Another cause, according to some writers, is the great admixture of the people of the country with the semitic race.

5. INFLUENCE OF INSTITUTIONS.

The term *institutions* is used here in its widest sense; it means, firstly, all the indigenous institutions not only as legally established, but also all the social, religious and political environments due to tradition and habits; and, secondly, all the intellectual and moral influences due to foreigners. It has a much wider meaning than the term hygiene. The institutions are more under the control of man than the three other causes which modify the vital functions.

Some philosophers, like Helvetius, maintain that «all men, ordinarily well organised, have the physical power of assimilating the highest ideas, and that the differences in culture which are noticeable in them depend upon various circumstances in which they are placed and to different educations which they receive» (1). Without subscribing entirely to this view, for it does not take into sufficient account their hereditary influences and traditions, there is no doubt that given a good and protective climate, a strong and intellectual race, and favourable geographical conditions, what distinguishes one nation from another, or, better still, one period of the history of a nation as compared with another period of the same nation, are its institutions or its ideals for the time being. It is not easy to determine always whether a trait of character is due to social, educational, religious, political or economic causes, for all are more or less inter-dependent. What is essential is that all should be harmonious, and well-balanced.

Many of the physical, moral and intellectual characters noticed in the preceding section, are influenced, for better or for worse, by institutions.

Socially considered, a Portuguese is very polite and deferential to foreigners, very hospitable, and so sympathetic that he has seldom the courage to say, no, to any request, so that *ele promete sempre, nunca dá,* or «he promises always, but never gives». Nevertheless he is quite honest. The women of the middle class, especially in the southern regions, are very dependent.

In religion, a Portuguese is simple in his faith and very tolerant of other beliefs. He practices the religious functions more in a social than in a religious spirit. His loss of faith is due to various causes, one of which

is the free and easy character of some of the clergy. In politics, he is passionately fond of his country, and extremely proud of its history. He is very liberal in his opinions, and, what is more, he is given not only to preach, as many others do, but also to put them into practice. He granted constitutional liberties to all the colonies and dependencies earlier than any other nation. His humane character may be attributed partly to the fact that the country is more agricultural than industrial.

The defects in the character of a Portuguese, as described by Prof. Teofilo Braga, are «a constant hesitation, incapacity in taking a prompt resolution, which renders him patient, condescending and visionary, without a spirit of enterprise, and any industrial originality» (2). He is also very credulous, and admires often all that is foreign and despises all that is national. This characteristic is old-standing, for Simão Machado, in his *Comedias Portuguesas,* published in 1631, says:

> *Emfim, que por naturesa*
> *E costoloção do clima,*
> *Esta nação portuguesa*
> *O nada estrangeiro estima,*
> *O muito dos seus despresa* (3).

Or that, «owing to the nature of the constellations regulating the climate, this Portuguese nation esteems whatever is foreign and despises all that is national». He suffers also from a disease which has been christened *verborrhoea,* that is, his delight in using one hundred words to express an idea which can be expressed in ten. The spirit of cooperation and

discipline is not so well developed as in some other countries.

The influence of institutions in the character of one and the same nation in different periods of history is well exemplified in Portugal itself. The mainsprings of action of the heroes during the brightest period of its history, 1490 to 1560, were a spirit of romance and adventure; an intense reliance in their own powers; an ardent faith in religion; and an ambition to amass riches. The highest watermark in literature, arts, and sciences corresponded with the highest ideals.

Among the *foreigners,* those who have influenced most during recent times the character and the ideas of the Portuguese are the French. This influence has not been, as a rule, beneficial; firstly, because the models selected for imitation have not been of the best; and, secondly, because both the nations have, more or less, the same spirit, the same temperament, the same inclinations. The French, who are sometimes styled «the spiritual godfathers of Portugal», have contributed rather to perpetuate the natural defects than to modify, to supplement, or to suppress them. They have been also the cause of the diffusion of some not very desirable ideas as regards politics and religion. They have increased the taste for the frivolous rather than for the serious. The French, it is needless to say, have some admirable models for imitation, but these do not attract the average Portuguese, who, like the rest of mankind, prefer to follow the line of least resistance.

Almost all the Portuguese public institutions are framed upon the French models, and have almost always very few of their good qualities and often a great many

of their defects. One of the causes of this is that some of the great politicians and leaders of thought know only French and no other foreign language. The French language has contributed immensely to corrupt the pure and musical national idiom. Nothing foreign, not even sports and pastimes, has any value in the eyes of the average Portuguese, unless or until it has received the *imprimatur* of Paris. The royal road to Lisbon lies through Paris, and through Paris alone.

The English have influenced to some extent the inhabitants of Oporto and its suburbs. The English education has a few admirers among the high, rich, and cultured classes.

It is curious to see that Spain does not exercise the slightest influence upon Portugal. There is not only a political, but also an intellectual barrier between the two countries. There is not a single official teacher of the Spanish language in Portugal, and likewise not a single of the Portuguese language in Spain. A Portuguese who reads one hundred books in French, does not read one single in Spanish, and a Spaniard pays him back in the same coin. There is also a social barrier: inter-marriages between the two nations are very rare. A Spaniard, as compared with a Portuguese, is more lively, more imaginative, and more religious. His language is more facile, more forcible, more eloquent, more caustic. There is more affinity between Portugal and Gallicia than between Portugal and any other neighbouring Spanish Provinces. The Gallicians, like the people of Minho, have less Moorish blood and more Romano-Wisigothic.

6. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS BASED UPON PHYSIOLOGICAL DEVELOPMENT.

There is yet no definite basis for the classification of climates upon the physiological development of the vital functions, or of the development of the body and the mind. The expressions used to show the characters of the climate are: protective, bracing, and relaxing. The only word which is most suitable is *protective,* for it implies not only the nature of the climate, but also its healthiness. Climates for physiological purposes may be classified into four groups: *a*) very protective, *b*) protective, *c*) moderately protective, and *d*) non-protective. These terms may be applied to the climate as a whole, or to each of the factors according to its normal influence. Taking the temperature by itself, a cold temperature is very protective; a temperate temperature is protective; a warm temperature is moderately protective; and a very cold or a hot temperature is non-protective. A temperature may be protective, but the moisture, the winds and the amount of sunshine may not be so.

Taking the annual climate as the basis, the North Atlantic region is very protective; the Lusitanian and the Mediterranean regions are protective; and the North and the South Continental regions are moderately protective. It must be remarked, however, that a climate may be very protective in winter and protective in summer, as in the Lusitanian region; or protective in winter and non-protective in summer, as in the South Continental region. The climate of altitudes may belong to any of the four groups. In sheltered situations, in

winter, it may be very protective. It is usually protective or very protective in summer.

One and the same climate may be protective to one person and not to another. A great deal depends upon the temperament, constitution, and age; and also upon the climate in which he was born and bred. A climate, however favourable it may be, ceases, like an article of food, to be beneficial after a time. The essencial conditions of a good climate, in the physiological sense, are frequent and moderate changes in weather, combined with a pure air. It has to be remembered that an agreeable climate is not always beneficial.

The general health of a person varies according to seasons. In the temperate regions the winter is more favourable to middle-aged persons than the summer. During the spring and the commencement of summer the children enjoy the best health; and in summer and early autumn, the old people. The hot and the warm seasons are not favourable to sustained physical or intellectual effort. Children pay more attention to their lessons in winter than in summer; in fact, the voluntary attention of students is in inverse ratio to the temperature.

7. EFFECTS OF THE FOUR CAUSES UPON THE DISTRIBUTION AND THE CHARACTER OF THE INHABITANTS; AND UPON THE TWO MAIN FACTS IN THE HISTORY OF THE NATION.

The climate, combined with the nature of the soil and of the institutions, determines the *distribution* or the density of the population of a country.

The population of Portugal is 5,547,710 or 62.5

per sq.km., distributed more or less as follows: North Atlantic region 107 per sq.km., Lusitanian 48, Mediterranean 50, North Continental 42, and South Continental 16. The density of population in the North Atlantic region is nearq 7 times more than in the Mediterranean.

The density of the population in the Lusitanian region is low because, for the purposes of these statistics, the whole of Portalegre is included in this region; in the same way, the density of the North Continental region is high, because the whole of Vila Rial is debited to it.

The density of the population is in correlation with the amount of the rainfall. It increases in the western littoral from south to north in the same way as the rain.

The influence of the social, economic and political conditions on the rise and fall of the population during the various periods of the national history has been studied by Soares de Barros (1), and by Rebello da Silva (2). The country has at present a larger number of inhabitants than ever before.

Compared with 62.5 inhabitants per sq.km., in Portugal, Spain has 37, and Great Britain, 133.

The mean number of *marriages* per 1000 inhabitants, according to the latest statistics, is 6.86. Broadly speaking, there is a decrease from the south towards the north; the highest rate occurs in the district of Beja, and the lowest in Vizeu. Spain has a higher rate than Portugal by 1.24, and Great Britain by 0.54. In this connection the emigration of males and females has to be taken into consideration.

In the latitude of Portugal, *conceptions* are moer

frequent in April, June, and May; and less frequent in November, September, and February.

Portugal was formerly known for its high *birth rate.* Polybius, writing in the II. century B.C., says: «Under the excellent climate of Lusitania the human race and the animals are marvelously prolific» (3). The birth rate in Portugal at present is 31.90, that of Lisbon being 26.63, and of Oporto 36.84. It is higher in Spain by 3.4, and lower in Great Britain by 3.7, and in France by 10.6 The percentage of illegitimate births out of the total births in Portugal is 12.71. It is less in Great Britain by 8.61, and in Spain by 8.21, and it is more in Austria by 0.09. The illegitimate births are dependent to a good extent upon the laws regarding divorce, and upon social influences. Just as legitimate births are not a guide to the virility and fecundity of the parents, in a similar manner the absence of illegitimate children is not a guide to chastity.

There is an annual increase of population by 12.1 per mille in Portugal. In Great Britain the increase is lower than in Portugal by 0.2, in Spain by 2.9, and in France by 10.4.

In the present state of social conditions, it is not of much use to compare the birth rates of one country with another, in order to find out the influence of climate or race, for the prudential restraints overpower the natural inclinations. These restraints have worked to such an extent that in one state the birth rate per marriage, which was 6.2 at the commencement of the last century, has fallen now to 1.81. In Great Britain there has been a drop of one-third in the birth rate of 1910 as compared with that of 1878. At present the birth rate represents rather the materialistic and egois-

tic characters of a nation rather than the ethical or religious. Some writers go as far as to maintain that a nation which has a high birth rate is in a backward condition!

In determining the birth rate several circumstances have to be taken into account: the ages of the married couple, the professions, riches and poverty, social and religious restraints, malarious fevers and other endemic or epidemic diseases.

The *character* of the population in the various regions vary according to the climatic and other causes. The following particulars are culled mainly from the works of Dr. Saldanha (4), and Oliveira Martins (5).

1) *North Atlantic region.* In subregion Minho the people are rather dull of intellect, ordinarily sedate, occasionally very gay and very fond of amusements. They are religious and musical. In business they are patient and hardworking, tenacious and ingenious. The abundance of natural productions render them happy, contented and well-nourished. In Beira Mar the population along the coast consists mainly of fishermen supposed to be of the Phoenician origin. The people are very hardy, but mild in temperament and very polite to strangers; they lead an amphibious life. In Beira Alta, the population is of the Lusitanian origin; it is not very vivacious, but is agile, robust and hardy. Its temperament is between phlegmatic and sanguine.

2) *Lusitanian region.* This region, in the Northern, Central and Southern subregions of Estremadura, presents a mixture of all the elements. There is a large number of people of Moorish descent in the environs

of Lisbon. As a rule, the people are very polite and refined, very cosmopolitan and very liberal. The peasants have a distaste to trees; they will destroy, if they can, all trees planted at the roadside. They are very fond of music. In Beira Baixa the people are inclined to be artistic and mobile in temperament, and in the Eastern Estremadura they are inclined to be melancholic.

3) *Mediterranean region.* The people have a practical turn of mind, they have a lively and jovial temperament and are excellent causeurs; they are inclined to be at times despondent and pessimistic.

4) *North Continental region.* The inhabitants are robust, with austere habits and a meditative turn of mind; they are agile, vivacious and hardy.

5) *South Continental region.* The people are clean-shaved, with gay eyes, vivacious movements, a noble and firm deportment; gallant, hospitable, jovial and communicative; the lower classes are ignorant and somewhat savage.

A human being is endowed with seven main instincts: communicative, dramatic, artistic, musical, inquisitive, religious and constructive. The Portuguese, considered as a whole, are well endowed or strong in the first four; they are weak in the inquisitive and religious; and very feeble in the constructive.

The *history* of the progress or retrogression of a nation depends upon many concurrent favourable or unfavourable conditions, one of which is certainly the climate. A nation may attain under favourable circumstances some indisputable advantages, and may decline for failing in others. The geographical features combined with the characters of the race have deter-

mined, under the lead of a score of men of high intellect and enterprise, the two main facts of the history of Portugal: its independence, and its maritime exploits.

«The continual existence of Portugal as an *independent* nation down to the present time», says Professor Oman, «in face of the persistent hostility and immensely superior force of its neighbour Spain, seems at first sight to be one of the most incomprehensible phenomena in modern history». And he adds. «Its geography turns out to be eminently suitable for resistance against an attack from the east» (6). These very geographical features have contribued also to give the people an intensely clannish feeling.

The quality of the race, combined with the position of the country, has led the Portuguese to lead an amphibious life from the earliest times. In 1333, the inhabitants of Lisbon and Oporto concluded a convention with Edward III. of England for permission to fish for 50 years off the coast of England and Brittany (7). This kind of life was a sort of practical school for the great *maritime exploits* which were to commence at the close of the XV. century. The discovery of the maritime route to India by Vasco da Gama, the discovery of Brazil by Cabral, and the circumnavigation of the world by Magellan are facts known to every school boy. Those foreign writers who have taken the trouble to study the history of Portugal are of opinion that the Portuguese are a people unequalled in the history of the modern nations. There is no doubt that, considering the size of the country and the number of inhabitants, Portugal has contributed, more than any other country of its size and population, its

quota to the progress of the human race. In fact, according to the well known dictum of Voltaire, «it is to the discoveries of the Portuguese in the old world that we are indebted to the new».

The total amount of population at the commencement of the XVI. century was only 1,800,000 or not more than 2,000,000, that is, less than two-fifths of the population of London at the present day.

The racial, the geographical, and the climatic features of Portugal are as favourable as they can be; and, if the institutions be sound and suitable, there is no reason why the country should not occupy, not perhaps that commanding position it attained once, but a primacial place among the nations of its size.

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CHAPTER XI.

THE PATHOLOGICAL EFFECTS OF THE CLIMATE.

The winds are the principal causes of all diseases.

HIPPOCRATES: On Winds, § 15.

1. THE CAUSES OF MORTALITY AND DISEASE.

Just as the favourable nature of the race, geographical features, climate and institutions produce health, vigour, natural decay and natural death, so, in a similar manner, their unfavourable nature produces feebleness, anaemia, degeneration, disease and premature death. The prevalent diseases and the rate of mortality form a better guide to the healthiness of a place than the influence it has in the prevention or cure of disease.

No writer has described more tersely and more accurately the influence of the climate and of the geographical features upon diseases than Hippocrates. His remarks on this subject, in his books on *Airs, Waters and Places,* on *Winds,* on *Epidemics* and on *Aphorisms,* are just as true to-day as they were 2000 years ago.

The influence of climate upon disease has been well

recognised by Charaka: «When the atmosphere», he says, «becomes as follows, it should be known as destructive of health, viz: contrary to (what is proper) the season, exceedingly moist, exceedingly changeful (as regards direction), exceedingly keen, exceedingly cold, or exceedingly warm, constantly pouring vapours, fraught with awful roars, blowing in different directions and counteracted in respect of its currents, blowing in whirls, and fraught with disagreeable scent, or vapour, or sand, or dust, or smoke» (1).

Diseases due directly and immediately to the climate alone are few. The ancients attributed diseases to miasms in the winds. Thanks to Pasteur and his disciples, most of these miasms have been demonstrated to consist of living germs. The climate influences the presence and prevalence of diseases in two ways: it favours on the one hand the development of germs, and on the other hand it affects the constitution of a person and predisposes him to disease. The nature of the climate determines the presence or the absence of many diseases.

The vital statistics in Portugal are still in their infancy. It is only since 1902 that statistics have been published showing the causes of mortality, as well as the ages of persons at the time of death (2). The causes of death are registered according to the nomenclature adopted at the Conference of Paris in 1900.

For the sake of convenience some diseases are grouped under one cause and some under another. It is difficult to ascribe always a definite direct or an indirect cause of a disease. Consumption, for example, is due directly to a bacillus, but indirectly it may be due to hereditary influences, to a very damp subsoil,

to bad and insufficient nourishment, to a moist and impure air, and to poverty and ignorance.

2. INFLUENCE OF RACE.

It is difficult to determine diseases due to race alone. In some cases there may be an increased susceptibility, and in others a relative immunity. As a rule, intermarriages among a limited class of society often give rise to physical and mental degeneration.

The disease in which there is an increased susceptibility in Portugal, as compared with some of the northern countries, is, perhaps, *diabetes*. The number of persons subject to this disease is very large, but as yet there are no accurate statistics on the subject.

The Portuguese are much less predisposed to *gout* than the British.

The mortality due to *cancer*, according to Dr. Neves, is only 2.18 per 10,000 inhabitants (1). It is 4.4 in Spain, 9.08 in Great Britain, 10 in France, and 12.5 in Switzerland. It is very probable that the Portuguese statistics are not quite accurate.

Scarlet fever is rare. It is not easy to say what is the exact cause; its absence may be due partly to race and partly to climate. The mean number of deaths due to this disease at Oporto, and also in Lisbon, is 2 per year. The highest rates occur in the districts of Braga, Vila Rial and Oporto: and the lowest in Evora, Castelo Branco and Portalegre. The disease is more common in the cold than in the warm regions.

There is a widely spread opinion among foreign writers that the Portuguese, as a race, have a comparative immunity against *syphilis*. This idea owes its

origin to Dr. Fergusson, one of the military surgeons in charge of the English troops in Portugal during the Peninsular war. «Compared with the British soldiers, he says, syphilis among the Portuguese is very mild; curable for the most part by topical application alone, or wearing itself out, when received into the constitution, after running a certain course (not always a very destructive one) without the use of any adequate mercurial treatment» (2). And this opinion has been shared, without question, by several authorities on syphilis. Dr. Düring, for instance, observes that, in the course of time, «the Portuguese have gained a relative immunity from syphilis» (3). Is there any real proof in support of this opinion? There is none. The observations made by Dr. Fergusson are quite accurate, but the inference drawn from them is not so. It is an established fact that the Portuguese soldiers in Africa suffer just as badly from syphilis as the English soldiers did in Portugal. The disease among the Portuguese soldiers in Africa is so severe that it has been styled *o galico negro*, or «the black syphilis». The differences in the disease as it affects soldiers in Portugal and in Africa are due, firstly, to the climate; and, secondly, to the consequent low state of their health. During the Peninsular War, the English soldiers, especially those quartered at Evora (where Dr. Fergusson made his observations), must have suffered greatly from the climate, and their health must have been below par. There is no wonder that they suffered more severely than their Portuguese comrades. It is necessary to see how syphilis affects the poor and the ill-fed people in Lisbon and Oporto before deciding whether the Portuguese are immune

to the disease or not. As a matter of fact, the Portuguese, as a race, have no immunity against syphilis. This question is so clear that it is needless to quote any authoritative opinions on the subject.

3. INFLUENCE OF GEOGRAPHICAL OR PHYSICAL FEATURES.

The influence of physical features cannot always be dissociated from that of the climate. The influence of the ocean, of altitudes, and of forests will be described in the next section in connection with the marine and other classes of climates.

There are many diseases due directly or indirectly to *soil*. When there is no wind all germs of diseases in the air have a tendency to settle down on the surface of the ground. The dampness of the soil contributes greatly to the prevalence of many diseases.

Malarial complaints are due directly to certain species of anopheles, and indirectly to the nature of the soil, for the insect requires a marshy soil or stagnant *water* for its procreation.

Malaria is still endemic in some parts of Portugal: in the High Douro and in the Low Alemtejo. It is also found in the low-lying grounds at the mouths of the Vouga, Mondego, Liz and Sado; in the *lezirias* or the rice-cultivating plains on the border of the Tagus beyond Santarem; and on some portions of the littoral of Algarve. The rate of mortality due to malarious fevers is highest in the districts of Beja, Portalegre and Evora; and lowest in the districts of Oporto, Vila Rial and Viana do Castelo. If Algarve, which stands as regards mortality next to Evora, be excluded, the disease may be said to decrease in proceeding north-

wards (1). The most common species of mosquitoes giving rise to malaria in Portugal is *Anopheles maculipennis.* Malarious fevers are more prevalent in late summer and in early autumn.

The sight of the sea or of rivers may give rise to sudden temptation to suicide in morbid conditions of mind.

The height of the subsoil water has an intimate connection with many other diseases such as tuberculosis, typhoid and typhus fevers, dysentery, diarrhoea, and cholera. Generally speaking, low plains, or those below 50 m. above the level of the sea, are suspicious, and may become dangerous if situated on the borders of lakes or rivers.

According to Dr. Bastos, the maximum number of people affected with goitre are found in the districts of Vizeu and Castelo Branco; and the minimum in Faro, Evora and Viana do Castelo (2).

Countries lying inland are less subject to the importation of diseases than those bordering on the sea. Lisbon, owing to its intimate intercourse with Brazil, was formerly liable to the introduction of yellow fever, just in the same way as Southampton, Marseilles and other large *seaport towns.* Fortunately this disease is dying out in America, and also much better precautions are now taken against its importation, and against that of other diseases, such as plague and cholera.

4. INFLUENCE OF THE DIFFERENT CLASSES AND SPECIES OF CLIMATES: EMIGRATION AND DISEASE.

Climates predispose directly or indirecty to many diseases, and influence the nature and course of all.

The species of climates which produce more diseases are the hot and very moist, and the very cold and very moist. The impurities in the air form a most important element as an immediate or direct cause of disease.

Each *class* of climate, combined with the geographical or physical features, has a tendency to predispose to certain diseases. The *marine* climates are liable to give rise to, as in the case of fishermen, rheumatic complaints. The *continental* predispose to bronchial affections and to diseases of the digestive organs. The influence of *altitudes* depends upon the constitution and the age of the individuals, and also upon the latitude in which the mountains are situated. Great altitudes give rise to mountain sickness. Mountain guides and persons who indulge in mountaineering are subject to dilation of the heart. Visitors to high altitudes are liable to inflammatory diseases and plethora in some cases, and to anaemia in others; some suffer from diarrhoea, and others from obstinate constipation. The mountain air is favourable to longevity as regards the permanent residents. The climate of *forests,* in winter, gives rise to bronchial affections and to rheumatic complaints. And all diseases prevail to a larger extent in *cities,* or other densely populated places, than in the open country.

Different *species* and *types* of climates have a tendency to produce different physical, moral and mental disorders. The climate may be good, but it may not be adapted to particular temperaments and constitutions. This is an important point for persons who intend to emigrate to diverse climates.

If the extremes of temperatures be excluded, the

injurious effects of a climate depend more upon moisture than upon temperature.

1) The influence of climates as a direct cause of *physical* ailments is not so very important as it was thought to be not long ago. The diseases due to climate alone, as distinct from those due to impurities in the air, are few. Climates have a decided influence in determining the general health, the constitution, and the temperament, and thus to create a predisposition to many diseases. Broadly speaking, cold climates predispose to diseases of the respiratory organs, and hot climates to those of the digestive system.

The inhabitants of a hot and very moist climate, and those of a very cold and very moist, have never attained, at least for any lengthened period, a very high degree of civilisation. In people of a hot and moist climate any heavy or continual work causes lassitude and fatigue.

Diseases and mortality increase in Europe from the higher to the lower latitudes, or from cold to warm climates. According to Quetelet (1), there was in 1869, one death in 41.1 inhabitants in the north; one in 40.8 in the centre; and 1 in 33.7 in the south. During the last century there has been a very considerable improvement in the public health everywhere. In Portugal from 1815 to 1819 the death rate was 1 in 40.0, and now it is 1 in 51.2. The mortality in Portugal itself is lower in the north than in the south.

It is not possible to discuss in these pages the influence of climate upon all diseases. A few remarks will be made only upon diarrhoea and enteritis, and upon bronchitis and pneumonia.

Diarrhoea and *enteritis* are more prevalent in the

south than in the north, and are much more frequent in summer than in winter. In persons above two years of age the mortality due to these complaints is almost double in the district of Faro (5.9) as compared compared with that of Viana do Castelo (3.2). A high temperature combined with a high moisture is more favourable to fermentation and the development of pathogenic germs than a low temperature combined with less moisture.

Bronchitis and *pneumonia,* on the other land, are more prevalent in the north than in the south, and more in winter than in summer. The rates of mortality, due to the two diseases, in the district of Oporto, are 7 and 9 per 1,000 inhabitants, respectively; and in Algarve 4 and 7. In the city of Oporto the respective rates are 17 and 7; and in Lisbon 12 and 7.

The prevalence of malaria, consumption, influenza and several other diseases is controlled by the climate. Generally speaking, the catarrhal and the inflammatory diseases prevail in the north, and the bilious and the intestinal in the south.

When the *food* and the *drink* are not adapted to the climate and the seasons, they give rise to disease. The same amount of animal food and of alcoholic drink in summer, as in winter, produces a disorder in the digestive system.

People eating damaged maize are liable to suffer from pellagra, a progressive disease of nutrition, giving rise to paralysis and progressive mental disorder. This disease has been noticed in Minho and in some other districts (2). Quite recently it has been attributed to impure water and not to damaged maize.

The purity of drinking water is of great importance.

In Lisbon, the death rate has improved very considerably since the introduction of a pure water-supply in 1880. In 1881-1885 it was 36.6 per mille; in 1900 to 1905 it fell to 24.74; and now it is still less. A great deal of disease and mortality in some of the villages is due to the deficiency and impurity of the water supply in summer and early autumn.

When the *dress* and the *habitations* are not adapted to the climate they predispose to certain diseases. Warm clothing in summer is a frequent indirect cause of sunstroke.

2) The *moral* condition of man depends often upon weather, or he is, in the words of Shakespeare, «servile to skyey influences» that hourly afflict him. A gloomy and foggy weather gives rise to depression of spirits. Broadly speaking, a cold climate, as in the North Atlantic region, predisposes to crimes connected with ambition and greed; and the hot, as in the Mediterranean region, to those connected with irritation or depression of spirits. In Portugal a large number of serious crimes is due to jealousy.

The prevalence of crimes in various parts of the country has been studied by Dr. Lopes (3). If the cities of Lisbon and Oporto be excluded, the largest number of crimes committed by men occurs in the districts of Lisbon, Evora, and Braga; and by women, in Bragança, Vila Rial, and Aveiro: and the lowest number commited by men occurs in Viana do Castelo, Caminha, and Leiria; and by women, in Leiria, Portalegre, and Santarem. Suicides are most prevalent in the heights of summer and winter. The number of homicides has recently been on the increase. In 1895 there were 1.83 in 100,000 inhabitants: in Great

Britain they were, at about the same time, one-half less; and in Spain about twice as many.

The maximum number of crimes against property occur in winter, and against persons in summer. For similar reasons the former are more common in the north, and the latter in the south. Suicides and crimes increase with the rise of the temperature of the air; whereas against property they increase in proportion to the decrease of temperature.

Drunkenness, and crimes connected with it, are comparatively rare. Competent observers believe that there has been, during recent years, an increase in the amount of consumption of alcohol. Sr. A. de Figueiredo (4) has calculated that the consumption of alcohol in the shape of wine is 8 l. per head. This quantity is equal to that consumed in Spain, superior to that in Italy, and inferior to that in France. Alcohol, not as wine, consumed per head is much lower than in France, somewhat higher than in Spain, and much higher than in Italy. There is a greater amount of drunkenness in February (probably due to the carnival) than in November. According to Dr. Fontes (5), crimes due to alcoholism attain their maximum in the districts of Lisbon, and Oporto; and their minimum in Vila Rial, and Bragança. Deaths due to alcoholism in Lisbon, in 1896, were 36 in men and 2 in women.

3) The climate has its share in the causation of *mental* disorders. Insanity increases with the temperature. The general tendency is an increase from north to south. In Algarve the percentage is very high. In Lisbon it is somewhat higher than at Oporto. The same holds good as regards congenital or acquired

idiocy. Clerical errors are more frequent in summer than in winter.

Of the *six prevalent species* of the Portuguese climate the most injurious, especially to weakly individuals, are the hot and very dry, and the cold and moist; the former gives rise to chills, and to derangement of the digestive and the nervous systems; and the latter predisposes to catarrhs, various forms of pulmonary and renal diseases, and to rheumatism. The worst climates, as a rule, are those in which the yearly fluctuations and the daily ranges of temperatures are excessive, and those which are excessively moist or excessively dry.

Sudden changes of weather give rise to many diseases. The people express this idea in the following aphorism :

Um dia frio e outro quente,
Logo um homem é doente.

Or «a man is at once ill if one day is cold and another hot». When there is an unusual change in the nature of the seasons there is likewise a great change in the nature of diseases, and in the rate of mortality.

Generally speaking, the most prevalent diseases in winter are influenza, bronchitis and pneumonia, pleurisy, rheumatism, apoplexy, and measles; in spring, coryza, cough, and headaches; in summer, gastro-enteritis, dyspepsia, congestion of the liver, and ophthalmia; and in autumn, typhoid and malarious fevers, tuberculosis, dysentery, and asthma.

The highest mortality among infants below one year of age occurs, according to Dr. Sobral Cid (6), in July, August, and September, due to diarrhoea; and among

children between 1 to 5 years, the highest occurs in winter, due to bronchial complaints. There are also more deaths in winter, after 60 years of age, likewise due to bronchial complaints.

Among the *emigrants* from a cold or a temperate climate, to the warm or the hot there is a predisposition to fevers and to other acute diseases, specially if they do not change their habits as regards food, drink, and clothes.

5. INFLUENCE OF INSTITUTIONS.

The prevalence of preventable diseases forms an excellent guide to the degree of the sanitation of a country. The prevalence of a great majority of preventable diseases is due to the want of, and not infrequently to the non-execution of, sanitary laws on the one hand; and to poverty, overcrowding, and ignorance on the other. It has been estimated that there are annually about 500,000 cases of avoidable diseases, and about 20,000 avoidable deaths. Perhaps there is some exaggeration in these figures. Bad water, faulty drainage, insanitary dwellings, adulterated food, and absence of public baths, are some of the causes of diseases in large towns. Only two diseases will be noticed here: small-pox, and infantile mortality.

1) The mean number of deaths due to *small-pox* during 1902 to 1905 was 1,140. Vaccination has been compulsory since 1899, and new regulations were made in August 1911, but the law has not as yet been put into full force. In Norway, where vaccination is compulsory, there were during ten years only 36 cases of small-pox, and not a single death.

2) The *mortality among infants* depends greatly upon economical, social and educational institutions. According to Dr. Cid, out of 1,000 births, 137 die within the first year of life, 78 in the second, and 58.8 in the next three years. During the first five years of life the death rate is 27.3 per cent. It is lowest in Minho, Traz-os-Montes and Beira Alta; it increases in Beira Baixa and Estremadura, and attains its maximum in Alemtejo.

Compared with the 13.7 per cent. of the death rate in infants below one year of age, it is 10.9 per cent. in Great Britain and 19.1 in Spain. The infant mortality during the first five years is extremely large in Portugal, 27.7.

6. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS UPON PATHOLOGICAL BASES.

The climatic regions may be classified according to the types of prevalent diseases; and according to mortality due mainly to climate.

1) As regards the *types of diseases*, the catarrhal and the continued fever are more prevalent in the cold belt; the entero-mesenteric and the intermittent fevers, in the temperate; and the dysenteric and the remittent fevers, in the hot. Portugal presents, in a limited sense, the types of diseases of the cóld climates in the North Atlantic and North Continental Regions; those of the temperate climates in the Lusitanian region; and those of the hot in the South Continental and the Mediterranean regions.

2) The rate of *mortality* due to climate alone cannot be easily separated from the general or total mortality.

There are many deaths due to preventable or contagious diseases and to accidents. The rate of mortality in a region does not necessarily indicate the prevalence of diseases in general, for 100 cases of simple malarious fevers and of rheumatism give rise to a much lower death rate than the same number of cases of typhoid fever and apoplexy. The rate of mortality is not a sure guide to the unhealthiness of the climate. A place may have very healthy climate and still the rate of mortality may be very high. A large infantile mortality due to bad and unsuitable food, for instance, cannot be attributed to the climate. A good guide to the general unhealthiness of a place would be the death rate combined with the percentage of the number of days during which the inhabitants of the place were unable to attend to their usual work owing to disease. Such statistics are not yet available anywhere. Admitting, for the sake of example, the mean death rate in Portugal due, directly or indirectly, to climate alone to be 10 per mille, the extreme north should have for climatic reasons 1 per mille less, and the extreme south may have 1 per mille more, the extreme variations being from 9 to 11 per mille. This ratio, it will be seen in the next section, is maintained more or less in the total rates of mortality.

7. EFFECTS OF THE FOUR CAUSES UPON GENERAL MORTALITY AND UPON THE PREVALENCE OF DISEASES.

The degree of the prevalence of avoidable diseases and of all avoidable diseases due to accidents in railways, factories, &c., forms a good thermometre to the degree of the civilisation of a nation. The more a

country is civilised the more value it attaches, not only to human life, but to all animal, and even vegetable, life. In comparing one country with another, differences due to the nature of the climate and other local conditions, such as density of population and large manufactories, have to be taken into account, although, due to strict attention to sanitary measures, such differences are being gradually reduced to a minimum.

The mean death rate in Portugal is 19.84. In the North Atlantic region it is 18.70; in the Lusitanian 20.06; in the Mediterranean 19.50; in the North Continental 19.63, and in the South Continental 21.07. The Lusitanian region presents a higher death rate than the Mediterranean owing to the city of Lisbon. In the district of Santarem it is only 17.20. The mortality increases from north to south. The death rate at Oporto is 31.5 and in Lisbon 23.2. Oporto ought to have a lower rate than Lisbon. If the two extreme littoral districts be compared, the minimum number of deaths occurs in Viana do Castelo in June, April, and May, and the maximum in August, February, and November; in Faro the minimum occurs in April, February, and March, and the maximum in September, November, and October. In Oporto the minima occur in May, June, and April, and the maxima in December, September, and March; and in Lisbon the former occur in June, September, and October, and the latter in March, January, and December.

In the whole of Portugal the lowest mortality occurs in April, May, and June; and the highest in August, September, and October. As regards ages the mortality among children below five years of age is highest in September, and in persons above 60 years of age, in

January. The mean death rate in Spain is 26.1, and in Great Britain 16.3.

The ten diseases which give rise to the highest death rates, in order of their frequency, are: 1) diarrhoea and enteritis in children below 2 years of age; 2) pulmonary tuberculosis; 3) congestion, hemorrhage and softening of the brain; 4) heart diseases; 5) pneumonia; 6) congenital debility and mal-formations; 7) senile debility; 8) acute bronchitis; 9) diarrhoea and enteritis in persons above 2 years of age; and 10) measles. It will be seen that many of the deaths are preventable.

The *prevalence of tuberculosis* is a good guide to the combined influences due to race, geographical features, climate and institutions. According to Dr. Jorge (1), there were, in 1903, 5.9 cases of consumption in 10,000 inhabitants. Lisbon and Oporto naturally furnished the highest percentages. Generally speaking, the disease increases from north to south. In the North Atlantic region it was 4.6; in the Lusitanian 5.1; in the Mediterranean 7.0; in the North Continental 4.3; and in the South Continental 4.8. The lowest percentage occurred in the districts of Leiria and Vizeu, and the highest in Algarve and Lisbon. The mean number of deaths due to this disease from 1905 to 1909 was 1,207. In the city of Lisbon the mean death rate due to tuberculosis is 3.1. Compared with England, the percentage in Portugal is more than double, and compared with Spain, it is less by about one-third. The main causes of the disease in Portugal are ignorance, dearness of the primary articles of food, and insanitary dwellings.

The prevalence of infectious diseases depends, other conditions being the same, upon the density of the

population. Measles, hooping cough, small-pox, and diptheria are more frequent in the North Atlantic than in the Lusitanian region; and more frequent in the Lusitanian than in the Mediterranean region.

According to Dr. Beddoe (2), the weakest points in recruits in Portugal are hernia, and diseases of the digestive and generative systems; in Spain, they are diseases of the respiratory organs, syphilis, hernia, diseases of the generative and digestive systems, and diseases of the eye; in Great Britain, they are bad teeth, and affections of the digestive organs in England; diseases of circulatory, urinary and digestive systems in Scotland; diseases of the circulatory system, of the skin, of the digestive system, and syphilis in Ireland; and phthisis, and diseases of the urinary and locomotive system in Wales.

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CHAPTER XII.

THE CLIMATE AS A THERAPEUTIC AGENT.

And what could not man do for himself, I mean to say for his own species, if his will was always guided by his intelligence! Who knows to what extent he could improve his nature, both as regards his moral and physical powers!

BUFFON: *Époques de la nature;* concluding lines of the 7th and the last epoch.

1. ON THE IMPROVEMENT OF THE VITAL FUNCTIONS OF THE BODY AND MIND, AND ON THE CURE OF DISEASE.

Just as certain causes give rise to physiological defects and to diseases, in the same manner the same causes in a different or modified form, can be utilised in their correction or cure. The climate of a country cannot be changed, but it can be and ought to be, wherever necessary, modified if possible. In every case the air should be maintained free from all impurities.

The medical profession, has, up to this time, devoted its time and energy to the cure of disease; and it has occupied itself with varying degree of success, in

different countries, with the prevention of disease or with public hygiene; but it has not yet taken its rightful share in the correction or modification of the general physical, moral or intellectual defects of a nation, or, in other words, in the general legislation from the medical point of view. Hippocrates, as already quoted, recognised how the institutions, or, in other words, proper laws and social opinions, were capable of engendering not only bodily vigour but also «courage and laborious enterprise». Among modern philsophers, D'Alembert, in his Analysis or Introductory Note to Montesquieu's *L'Esprit des Lois,* recommends that the laws should be framed to accord with the nature of the climate: «Thus, in countries where the use of wine is hurtful, the law that checks its use is a very good one; in countries where the heat of the climate inclines people to laziness, the law which encourages labour is a very proper one. Therefore governments can correct the bad effects of climate».

No other profession studies the human body more accurately than the medical; and hardly any other profession has such opportunities to observe so minutely and so frequently the different phases of the human mind and character. The medical profession has, therefore, a right to claim its share in the resoluton of problems relating to the physical, moral, and intellectual education of a nation, and in questions relating to social, economic and even religious laws. For this purpose it would be exceedingly useful if the medical faculties would establish chairs to discuss the problems connected with the general legislation of each country, so as to prepare some of the medical students to take their share in the higher responsibilities of life. They

should be specially taught the conditions of national health, both as regards body and mind, or the science of anthropology in the widest sense of the word. According to the often quoted opinion of Descartes, «if the human species is to be perfected, it is in medicine that it is necessary to search the means».

The use of climates in the treatment of *diseases* has been recognised by many professional and non-professional writers from the earliest periods of history.

2. INFLUENCE OF RACE.

The tendency to certain constitutions, temperaments, and diseases due to climate can be modified or prevented in certain families by means of suitable marriages. If a person belongs to a family with a weak physique and an obtuse intellect, he would be well-advised to marry in a family of good physique and high mental power; if he be a member of a neurasthenic family, he should select a partner with a sanguine temperament; and if he belongs to a consumptive family, he would do well not to marry at all, or to marry in a family with a rheumatic diathesis, for it is supposed that rheumatism is more or less a bar to tuberculosis. Just as marriages and inter-marriages among limited number of families give rise to physical and mental degeneration, in the same way inter-marriages among different good races often give rise to, provided the social environment be favourable, improvement of both the body and mind.

The relative immunity of the Portuguese to certain diseases has already been described (Ch. X. 2). It

is possible that gout and scarlet fever are more easily cured in a Portuguese than in individuals of some other races.

3. INFLUENCE OF GEOGRAPHICAL OR PHYSICAL FEATURES.

One of the aims of governments and of municipalities should be to preserve and improve the scenery of a country, for a beautiful aspect of nature contributes to the well-being of the people.

Many laymen and even some medical men, who are not personally acquainted with the local conditions of Portugal, judge of the nature or the uses of the climate according to the *latitudes* of the different places. This leads to great mistakes. Owing to the Gulf Stream and the absence of snow-covered mountains, the diurnal range of temperature on the coast of the Lusitanian region is much lower than that on the coast of Algarve, Andalusia and Granada.

A temperate climate in low latitudes has not the same influence in the treatment of disease as one in high latitudes. The difference is very noticeable in the development of the white races. These do not attain their highest level of development in the highlands or *mountains* of the tropics as they do in the temperate latitudes, although the temperature be the same.

The injurious effects due to the dampness of the *soil* can be modified or corrected either by means of drainage, or by preventing the flooding or sodding of the soil by means of protective works.

A proper system of drainage has the effectof

increasing the temperature and in decreasing the relative humidity and mists. The temperature of a drained soil, as compared with the undrained, is higher by $0^{\circ}.5$.

Drainage by rendering the surface of ground dry deprives mosquitoes of their breeding medium, and so diminishes malaria; and by lowering the subsoil water, decreases the prevalence of tuberculous diseases and rheumatism. A well conducted drainage system of the malarious localities (Ch. XI. 2) would extinguish the disease in a few years.

Another way of diminishing the water-logged condition of the soil of towns bordering on rivers, lakes or coasts is to build protective walls, so as to prevent the filtration of water in the neighbouring soil. Such works carried out often for commercial purposes are very beneficial from the climatic and hygienic point of view. Similar works carried out in Lisbon, Setubal, and Coimbra have reduced considerably the sickness and mortality in those cities. A fever known in Lisbon as the «river fever» has completely disappeared, at least in the central portion of the city.

When protective walls cannot be built, the borders of rivers and rivulets can be protected by the plantation of the poplars *(Populus alba* and *P. nigra)*, the willows *(Salix fragilis* and *S. alba)*, and by the reed *(Arundo Donax)*.

The reverse of drainage is *irrigation*. When large irrigation canals are opened for agricultural purposes, they influence to some extent the climate of the country. They diminish the high temperature and increase the moisture of the air, and also to some extent the amount of rainfall. A well divised system

of irrigation of the plains of the S. Continental region would be beneficial both from the agricultural and the climatic point of view.

Where masonry walls cannot be built, for they are costly, the *plantations* of pines such as those initiated by D. Sancho and extended by D. Deniz in Leiria, have the effect of not only preventing the encroachment of the sea, but also in modifying the marshy condition of the soil. There is ample room for similar improvements at Espinho and Granja, and in many other places on the coast, and also along the plains bordering on the Tagus, the Sado, and some other rivers.

The afforestation of a country has the effect of decreasing the temperature during the day in summer, and in preventing the rapid radiation of the heat during night; in checking the evaporation from the soil; and in increasing to a slight extent the amount of rainfall. The S. Continental region can be greatly benefited by an extended plantation of chestnut trees, and the Corsican pines.

An extensive plantation of blue gum-trees has the effect of diminishing the dampness of the soil. A striking example of this kind is given by the late Sr. Guerreiro (1). At Vila Fernando, where he had the charge of the Reformatory School, he found the country devoid of vegetation, the soil clogged with water, and the inhabitants subject to malarious fevers. The daily range of temperature, or the difference in temperature between day and night attained even 30°. He planted 100,000 eucalyptuses, and rendered the ground so dry that after some years there was a decided decrease in the prevalence of fevers; and the

difference of temperature between day and night did not exceed 18° degrees.

Similar improvements can be carried out in some other marshy grounds in various parts of the country.

The climate of certain cities and towns can be modified, to some extent, by planting in suitable situations a row of tall trees. There is room for such improvements in Lisbon and at various other places.

By preventing the overcrowding of houses, by a large number of open squares or gardens, and by other means, the climate of a *city* can be rendered nearly similar to that of the neighbouring open country.

4. INFLUENCE OF DIFFERENT CLASSES AND SPECIES OF CLIMATES. PERSONS UNFIT FOR EMIGRATION.

The physiological defects due to climate can be modified by appropriate institutions; and the diseases due to climate can be treated by appropriate institutions, appropriate change of air whenever possible, and by appropriate medicines with a suitable diet.

The different *classes* and *species* of climates are useful in the treatment of different constitutions, different temperaments, and different diseases.

The effects of the three zones of the *marine* climate are not the same. Due to high barometric pressure, low daily and annual range of temperature, higher absolute humidity, strong winds, and great purity of air, there are in the *littoral* or the *saline* zone greater nutritive changes, as shown by an increase of urea and of sulphuric acid in the urine, and a decrease of uric and phosphoric acids; an increase of appetite and a decrease in the number of

respirations and of pulsations; and better sleep. The amount of urine is increased, and so also the weight of the body. In some cases there is nervous excitement followed by loss of sleeep. The body loses its heat with greater ease at the sea shore than in inland places or in altitudes. This climate may be described, in favourable situations, as gently sedative and stimulant, the sedative effects being due chiefly to the equable temperature, and the stimulant action to the winds and breezes.

The littoral zone is useful in anaemia and debility and in convalescence from many acute diseases; in nervous depressions due to over-work; in chronic pleurisy, chronic bronchitis, and, in suitable situations, in some few cases of incipient tuberculosis. As a rule, the saline zone is useful in tuberculosis of bovine origin, as seen in the enlargement of glands and in diseases of bones. Some places in the saline zone, where there are extensive plantation of the pine, are also useful in tuberculosis of the lungs or in tuberculosis of human origin. This zone is particulary favourable in anaemic and scrofulous children and in senile debility. Provided other conditions are favourable, it is also useful in malarious fevers. Some hysterical persons, and those suffering from chlorosis and amenorrhoea likewise do well.

The *sea-breeze zone* is less stimulating and sometimes more soothing. Some persons can sleep better in this zone than in the saline.

The influence of the *inland marine* zone depends upon the altitude of the place and upon the amount of vegetation. The climate of moderate altitudes near the sea is less tonic and more stimulating.

The littoral zone is contra-indicated in advanced cases of heart disease, of Bright's disease, of consumtion and of gout. Some sea shores are more injurious than others. Some especial cases of incipient consumption find a temporary relief in favourale situations, but in the great majority of cases the climates of altitudes are much more favourable than the marine. The littoral climate is also contra-indicated in haemorrhoidal congestions, in biliary lithiasis and in some cases of chronic congestion of the stomach and the intestines, and in neurasthenia.

Owing to the great daily and annual range of temperature, the *continental* climates on the plains, if not well-sheltered or exposed to some favourable circumstance, as that of a forest, are not of much use to an invalid. In fact, there is no climatic station in great request in Portugal in the plains of the continental regions. Under favourable conditions and in proper seasons, such stations are useful in some irritative affections of the respiratory organs, and in many cases of the circulatory and renal systems.

Different *altitudes* are useful in different diseases.

A station of *high altitude* in Portugal requires an elevation of 1,400 to 1,800 m. Due to low pressure, low temperature, and greater dryness and purity of the air, there is rapid evaporation, the skin becomes dry and cracked, there is greater thirst, the respirations are more frequent and there is a greater amount of expiration of carbon dioxide, the blood shows an increase of red-corpuscles; shortly, the nutritive changes are greater and there is greater resistance to diseases.

Antyllus noticed long ago that the elevated localities were more healthy than the low, for the air on altitudes

was constantly renewed (1). Properly selected high altitudes are very useful in chronic and torpid tuberculosis of the lungs, and in all diseases which require stimulation of organic life, in convalescence from acute diseases, anaemia, physical and mental exhaustion, neurasthenia and hysteria, bronchial catarrh, and some cases of asthma. Provided there is sufficient power of resistance, they are useful in some cases of diabetes. At high altitudes there is an immunity from consumption, yellow fever, and typhus. There is yet no suitable station of high altitude in Portugal, although there are excellent places for its establishment.

High altitudes are dangerous to old people, to those subject to heart disease and arterio-sclerosis; and in high fevers, and neurotic persons. In winter, owing to the extreme variations of temperature during day and night, they are injurious to the gouty and the neurasthenic.

The climate of *medium altitudes,* 700 to 1,200 m., is less stimulating or more sedative. It is useful in some heart diseases, and in nervous and impressionable subjects.

The value of *low altitudes,* 400 to 700 m., depends more upon their exposure to favourable or cool winds in summer, and to their woods. Their climate is mildly tonic and stimulant; in well-sheltered situations they act as gentle sedatives.

The *forests* and *woods* of pines and of blue-gum trees are useful in some complaints. In summer some stations of low altitudes, owing to the presence of extensive woods and to the greater amount of atmospheric moisture, give rise to a sensation of cold quite disproportionate to their height. This cold has not the

same stimulant action as that due to altitudes. Stations with woods are useful in summer in broncho-pneumonia, but injurious in rheumatic affections. Such stations are not of any use for invalids in winter.

The only diseases in which the climate of a *city* is found sometimes useful are asthma and hay-fever. All weakly children and old people resident in large cities do well by a change to the sea-shore, whereas all middle aged persons, whose health is below par, find greater relief in altitudes.

Different *species* and *types of climates* influence in different ways the physical and moral condition of man.

1). The defects due to climate in the *physical* development as regards height and weight can be corrected by a well-regulated system of physical education. There is a great need of such an education among the middle classes, and specially among the girls and women of this class.

The *food* and *drink* have to be regulated according to climate. The evil effects of hot or warm climates in summer can be avoided by eating more vegetable food than in winter, and by the abstention from alcoholic drinks. In all climates and in all seasons the purity of water has to be attended to. The water from wells is likely to become impure in late summer and in early autumn.

Suitable *clothing* and proper *ventilation* of dwellings according to seasons would cure or prevent some diseases.

2 & 3). The *moral* and the *intellectual* character of a nation cannot be changed, but it can certainly be modified. The whole aim of education should consist in suppressing that which is excessive or disadvantageous

in the national character, and in supplying that in which it is deficient. When the influence due to religion slackens, it is essential that the social control should be proportionately strong.

Great grief, violent passion, despondency, melancholia, depression or irritation of mind are all benefitted by a suitable change of climate and of scenery.

The crimes due to jealousy and love can be reduced by the control of erotic literature and of pornographic pictures. It would be beneficial also if the newspapers would cease to publish lengthy reports of crimes, and if they would banish from their columns certain objectionable advertisements. Another and more efficient way of diminishing crimes would be to open more schools, for according to well-known aphorism of Victor Hugo «to open a school is to close a prison».

Out of the six *species* of climates the most favourable, in winter are the temperate and dry, as it is found in the Lusitanian region, and the temperate and moderately dry, as in the Mediterranean region; and, in summer, the warm and moderately dry in the N. Atlantic Region.

The *temperate* and *dry* climate in winter is useful in disease contracted in cold regions, such as anaemia, chronic rheumatism, gout; in many cases of bronchial catarrh and emphysema, in lung affections with profuse expectoration, and in renal complaints. The more feeble the patient the greater should be, as a rule, the temperature.

The same climate is also useful in diseases contracted in hot climates such as congestion of the liver, chronic dysentery, or chronic diarrhoea, chronic dyspepsia, malarial fever, and neurasthenia.

The *temperate* and *moderately dry* is especially useful in cases of lung disease with scanty expectoration, and in irritative affections of the throat. Some cases of asthma do extremely well in this kind of climate.

The *warm* and *moderately dry* in summer is useful in debility, in sleeplessness due to intellectual work, in scrofula and rheumatism, and in chronic pneumonia.

In selecting a climate it is necessary to take into account the type of the climate in which the disease was originally contracted.

In the treatment of disease the mean temperature and the mean amount of moisture are not the only conditions. A difference of 1° or 2° degrees of temperature is not of much consequence provided the daily range be low, the winds be moderate or feeble, and there be, in winter, a mean amount of sunshine of 3 or 4 hours per day.

In the case of permanent residents, the constancy of the climate is of importance to those who suffer from chronic diseases, for in climates where the weather is very variable there is a danger of chills. This fact was well exemplified in the various expeditions to the poles, in which, provided due precautions were taken, there was less danger in catching colds than in London, Paris, or Lisbon.

Among the permanent inhabitants of the temperate belt the *seasons* have, irrespective, within certain limits, of the types of climates, a definite influence in treatment. Generally speaking, the winter is favourable to the treatment of diseases of the digestive and the nervous systems; and the summer to those of the respiratory, circulatory and renal systems.

Taken as a whole, the *littoral* and *the sea-breeze*

zones in Portugal are more agreeable to an invalid for residence throughout the year than any other zones or regions which are inland, for on the sea-shore the winter is warmer and the summer is cooler than in the corresponding latitudes and altitudes inland.

By minute observation of the meteorological phenomena of one season, the character of the diseases which may be expected in the next season may be more or less predicted. An old aphorism says: *Aestas sicca, Roma perpetuo saluberrima.* The treatment of diseases is easier when the seasons are favourable.

A great deal of sickness and misery could be avoided if all *emigrants* would consult their medical advisers before leaving the country. Persons of sanguine temperament, and those with a tendency to gastric or liver complaints should not emigrate to a hot climate; the best temperaments to go there are the lymphatic. Persons with a nervous temperament, if not highly sensitive, can bear a good deal of fatigue in all climates. All persons emigrating to a hot climate should make up their minds to lead an abstemious life.

5. INFLUENCE OF INSTITUTIONS.

The progress of modern, or quite recent, civilisation is marked by a continual and persistent ascendancy of the educational and social institutions over the racial, geographical, and climatic factors. The advancement depends upon the nature of the educational, the social, the religious, the sanitary, the criminal, the temperance, the economic and other laws and institutions; it depends in fact upon the collective will of the nation itself.

It is useful to remember always that it is not enough to have good laws in the code, it is necessary to put them into execution.

The Portuguese are altogether under the *moral* and *intellectual* thraldom of France. They accept without question the French guidance, the French example. This is injurious, for it tends more to exaggerate the natural defects due to the race and to the climate, than to correct, to modify, or to supplement them. The best world type of mankind of the future would be, in the opinion of some anthropologists, a mixture of the slavonic with the mongolian. The best type of European civilisation, or of individual culture, at present, is a mixture of the Latin with the Anglo-Saxon. Each taken separately has its peculiar advantages and defects.

The extreme love of romance and poesy, the general tendency to exaggeration and day-dreaming, the verbosity with great flourishes of rhetoric, can be best cured by making the German or the English language compulsory in all the schools and colleges, and allowing the knowledge of French an optional subject, or in other words, by urging the cultivation of the German or the English mode of thought instead of the French. The German is perhaps preferable to the English, on the principle of *contraria contrariis,* for the German genius is further removed from the Portuguese than the English. The French themselves have found it out. It is necessary to render all public instruction more practical and useful. It is necessary also to instil into the minds of the public in general saner ideas as regards the dignity of labour and business. In order to avoid any misconception of the views expressed

here, it may be noted that the French culture is in no way inferior to the German. In many respects, as evidenced by some recent discoveries and inventions, it is far superior. But it is not adapted to the Portuguese climate, and to the average Portuguese temperament. On the same principle, the average German would be greatly improved by a certain amount of the Portuguese or Latin culture. Superior minds in all nations will always soar high over all difficulties; it is the average minds that require to be guided and controlled by appropriate laws and appropriate institutions.

The striking influence of education is well exemplified by those students who have studied in Germany, England, and Switzerland, as compared with those who have studied in France. The former come back with their practical sense greatly developed, the latter with a great deal of theory; the former prefer facts, the latter often sacrifice facts to the beauty of expression. It has to be acknowledged, however, that during the last few years there has been a great change in the system of education in France. In the Sorbonne the German influence is now predominant. But there is no reason why the Portuguese should buy their German ideas at second-hand.

The influence of education is also very strikingly illustrated in the formation of the character of the people of the same race, inhabiting more or less the same climate, who come under the Governments of Portugal, England, France, and Germany in different parts of the world.

There is a great need of some new laws for the prevention of many avoidable diseases: and there is a great need for the strict execution of many laws which

exist only on paper. The large number of deaths due to small-pox and tuberculosis, and the high rate of mortality among infants demand instant attention. As the dearness of the primary articles of food is the cause of many diseases, it is necessary to revise the fiscal and other laws.

It is not easy to form an accurate idea of the death rate and prevalent diseases of all the communes (Concelhos) or municipal centres of Portugal. It is absolutely necessary to publish an annual report showing the percentages of births and deaths of each centre, together with a note as regards the prevalent diseases and their causes. The information furnished by each municipality need not occupy more than 10 lines, and as there are about 268 concelhos, the whole report could be comprised in 2,680 lines, or about 50 to 60 pages. Such a publication would be an inducement to the various municipalities to emulate in the improvement of sanitation in their respective communes.

6. CLASSIFICATION OF THE FIVE CLIMATIC REGIONS UPON THERAPEUTIC BASES.

Therapeutically considered, climates may be divided into stimulant, sedative, tonic, relaxing, and depressing.

It is not easy to classify the different species and types of climates according to their therapeutic effects in all diseases, for one and the same climate often acts differently not only in different persons but in the same person, according to the cause of disease, according to the particular stage of the same disease, according to the age of the patient, and according to his nutritive powers for the time being; or, in other words, a climate

which is sedative under certain conditions may be stimulant when the conditions are reversed.

Generally speaking, the various climatic elements which characterise the five classes of therapeutic climates may be stated thus:

Stimulant: Low pressure, warm and moderate range of temperature, dryness of the air, moderate winds, strong and prolonged sunshine in winter.

Sedative: High pressure, cold and equable temperature, moderate moisture, rainfall especially during night, feeble winds, moderate sunshine without glare.

Tonic: The stimulant or the sedative climates act as tonic according to the condition or needs of the invalid. In either case the action should be moderate.

Relaxing: Very high pressure, high temperature, excessive moisture, very feeble winds.

Depressing: When the relaxing elements are accompanied by persistent cloudiness, continual rain, no winds, no sunshine, and all atmospheric phenomena preceding a storm.

The climatic zones and regions which are most favourable in treatment are:

a) The littoral zones of the Lusitanian and Mediterranean regions in winter.

b) The littoral zones of the N. Atlantic and the Lusitanian regions in summer.

c) The moderate and high altitudes in summer.

d) And all well-wooded places, also in summer.

These remarks are to be taken in a general sense, for with a good shelter or a good exposure, a good climate can be found, in at least one of the four seasons, in all the regions. The continental regions are less favourable than the marine.

7. EFFECTS OF THE FOUR CAUSES UPON HEALTH AND LONGEVITY.

If the climate of a country be healthy, if the hereditary conditions of the population be sound, and if all the institutions be adapted to the climate and to the race, there is no reason why the great majority of the population should not attain the maximum development of body and mind of which they are susceptible, and why they should not attain the age of 80 years or more, and die of natural senile decay.

In the census of 1900 it was found that in a population of 5,016,267, there were 49,439 persons between 75 and 79 years of age; 32,736, between 80 and 84 years; 9,572, between 85 and 89; 3,192, between 90 and 94; 952, between 95 and 99; and 316, over 99 years.

Owing to the high death rate among children below 5 years of age, the mean age at which a Portuguese dies is low. The expectation of life of males at birth in the British Isles is 41.95 years.

In the rural districts people live just as long or somewhat longer than they did formerly; the longevity in towns is much greater now than it was 50 years ago.

If all the institutions be improved, there is no reason why the mortality in Portugal should not be reduced to 15 or even 14 per mille, and the mean duration of life raised to about 42 years.

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PART II.

NOTES ON THE HEALTH RESORTS OF PORTUGAL.

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CHAPTER XIII.

PRELIMINARY REMARKS ON HEALTH RESORTS AND THEIR ADJUNCTS.

A change of climate is good in chronic diseases.

HIPPOCRATES: *On Epidemics.* Sect. V. 13.

Within the Waters dwell all balms that heal,
The Waters hold all medicines.

MEDÂTITHI, *in Rigveda*, B. 1., h. 23, l. 20.

1. THREE MAIN GROUPS OF HEALTH RESORTS.

A health resort is a place where a person regains his normal health more rapidly than at the place where he usually resides. Some health resorts are visited more for pleasure than for health.

Health resorts (Map II.) may be grouped under three main heads: the climatic, or those frequented for their climate; the spas, or those frequented for their baths and mineral waters; and the sea-bathing resorts, or

those frequented both for their climate and for their baths. Some of the spas are also used as climatic resorts. Besides these three groups, there are resorts for special cures, such as those for the grape or the fruit cure, and those for the whey cure.

Each resort, like each human being, has its distinctive physiognomy and peculiar characters, which can often be seen and felt but cannot be always easily described. Each resort is often more useful in certain months, and in certain diseases than in others. Some writers imagine that a resort belonging to a certain class or species of climate is as good as another. This is not the case. All marine resorts with a temperate and moderatly moist climate do not act in the same way. Each has its typical characters and typical uses.

The climate of a station may be all that is desirable, and the baths and mineral waters may be excellent, but they are not likely to be frequented with pleasure by a foreigner unless his special requirements as regards accommodation, food, sanitary arrangements, and amusements are attended to. On the other hand, a station may fulfil all the requirements, and still an invalid, owing to his own faults, may not obtain good results from its use. He often forgets that he has to conform always to the ordinary rules of hygiene at all places, and to particular rules at each place in each country.

Celsus gives minute directions as to what the weak and the convalescent should do in order to regain their health. Among other things, he recommends a warm bath, from which they should get out after a while and «get themselves anointed and lightly rubbed», after which they should get into the bath again (1).

The custom of anointing the body with oils has fallen into disuse in Europe. There is repugnance to the use of oils. Lord Bacon, one of the keenest observers of nature, is of opinion that the anointing of the body with the oil of olives or of sweet almonds in the morning, before bathing, would be beneficial to health (2). The custom is certainly useful in warding off or in enduring excessive heat.

In Portugal an invalid has to guard himself, even in winter, against excessive insolation, and against the immoderate use of tempting fruit.

2. CLIMATIC RESORTS.

There are several classical writers, both professional and lay, who recognise the value of a change of climate in disease. Among modern English physicians, Gregory remarks: «Many diseases which cannot be cured by any other remedies are spontaneously relieved or cured by changing the air or the heavens» (1). And Armstrong says:

> «Ye who amidst this feverish world would wear
> A body free from pain, of care of mind,
> Fly the rank city, shun its turbid air...,
> Find some woodland scene, where nature smiles
> Benign, where all her honest children thrive» (2).

There is no doubt that an appropriate change of climate often gives an invalid a new lease of life.

The Romans had, during their domination in Portugal, their climatic resorts, one of which was situated at or near Alcacer do Sal, with a temple dedicated to the goddess Salacia, and was frequented by the patri-

cians of *Liberalitas Julia*, or of Evora. But almost all the present climatic stations owe their origin, directly or indirectly, to the friars who for many centuries had the monopoly of all sciences, and who showed almost always excellent judgment in the selection of sites for their monasteries. As a rule, it may be laid down that wherever there is, or there was, a monastery or a convent in the provinces, there the climate is good, at least for the greater part of the year, and the water-supply is pure and abundant. Bom Jesus do Monte, Bussaco, Cascaes, Cintra (Pena and Penha Longa), Estoril, Estrela, Monte Regina (Arrábida), and Santa Luzia (Viana do Castelo) are some examples to the point. In connection with this subject it may be mentioned that the first Portuguese medical writer, whose works are extant or published, was a priest, Pedro Julião, a native of Lisbon, who afterwards became a Pope under the name of John XXI. (1276-1277). His *Thesaurus pauperum* (3) was in the XIII. century one of the text-books in medicine in various centres of learning all over Europe. Not to mention other countries, there are two manuscript copies of this work in England: one at Oxford, and the other at Cambridge. It was translated into English by H. Lloyde in 1550 (?). Pedro Julião was known to his fellow students and friends as the *magister universalis*, for he had graduated in all the faculties of the University of Paris. In his writings he was greatly influenced by the works of Roger Bacon, the *doctor mirabilis* of his friends and contemporaries.

The merits of the climate of Portugal were well recognised by the British physicians from about 1750 to 1820, when many of the invalids requiring a mild

and healthy climate were sent to this country, but owing, on the one hand, to the political commotions, to the lack of rapid communications, to the want of comfortable accommodation, and to the ignorance of the subtle art of advertisement; and on the other hand, to the erroneous views held and propagated regarding the temperature, the rainfall, and the winds, the country fell into neglect. Now, since 1904, there is a revival, a decidedly renewed interest in the climatic resources of the country.

A climatic resort partakes the general characters of the class and of the species to which it belongs. A large climatic resort has not only different climates in different seasons, but also different climates in different situations. The climate of Belem in Lisbon, for instance, is quite different from that of Bemfica. In a summary description of a climatic resort it is necessary to note, firstly, the class and the sub-class to which it belongs; secondly, its species in winter and in summer; and, thirdly, its typical characters.

With the exception of two or three places, the therapeutic uses of the climatic resorts have not yet received much attention. The use of each resort has to be studied separately, and if possible, has to be specialised. The subject requires careful, dispassionate, and prolonged observations. This study is difficult, for the climatic conditions cannot be renewed at will. The value of a climate may be judged partly by its positive or curative effects, and partly by its negative influence or by the absence of certain diseases and by the rate of mortality.

Climatic resorts are frequented not only by invalids and convalescents, but also by more or less healthy

persons who require mere rest and repose from their active professional or business life. An accurate knowledge of the climatic resorts of a country places in the hands of a judicious physician a powerful means for the preservation of health, for the prevention of many threatened weaknesses, and for the alleviation and cure of many chronic ailments. In fact, some diseases, such as scrofula, rheumatism, gout, laryngitis, and goitre; some complaints of the stomach, liver and nervous system; and some cases of consumption, and chronic pleurisy, are better cured or relieved by a change of air than by any number of drugs. In general terms, it may be said that all diseases, contracted both in the cold and the hot belts, are relieved by a change to a temperate climate.

Irrespective of the class and the species of climate, the place where a person is born and bred impresses upon him certain physical and psychical characters, which often act beneficially when the same person having resided elsewhere returns to his native air. The native air also acts beneficially because its climatic characters are often opposite to those which gave rise to the disease.

The climate of a station may be all that is desirable, but the weather in a particular season of the year may not be favourable, so that the expectation of good results from a change of air to that resort may be falsified by accidental or unexpected circumstances.

Some invalids in the cold belt imagine that by going to a particular temperate resort they are sure of finding a summer instead of a winter. They are quite mistaken. There is no place in Europe where a winter can be avoided. Everywhere there is rain or snow,

everywhere there are good days and bad days. The only difference between one resort and another consists in the number of hours of rainfall and of sunshine, in the degrees of temperature, in the percentages of moisture, and in the force of winds. Portugal in these respects has a decided advantage over all other countries.

When an invalid changes from a cold to a warm climate, he often feels a great desire to eat more and to take active exercise. He has to curb both these inclinations. In fact, it would be wiser for him to diet more strictly and to take rest for the first week, so as to get himself acclimatised to the place. These are common sense rules, but they are often neglected.

Some climatic resorts are at their best in winter, some in summer, and others in spring or in autumn. There is no resort equally good throughout all the seasons.

There are some monographs devoted to the study of particular resorts, and to the selection of a climate in tuberculosis, but as yet there is no book on all the climatic resorts. The reason is, climate has not the same practical interest to the inhabitants of the temperate belt as it has to those of the cold or the hot. It is due to this fact, that the British take more interest in practical climatology. It is they who have led the way to Madeira, to the Azores, to Cintra, to Mont' Estoril, and to numerous other places both in Europe and elsewhere; and it is they who form about 90 p. c. of the foreign cold season visitors in Portugal.

Portugal presents a great variety of climates, some of which are, if I may say so, of international interest. Many localities well recognised for their beneficial

effects remain to be explored or utilised. There is an ample field for commercial enterprise in this respect.

3. SPAS.

For medical purposes mineral waters are those which, owing to their temperature or chemical composition, have definite therapeutic uses. Some waters are chiefly used as baths, some chiefly as drinks, and a good many for both purposes.

The therapeutic uses of baths and mineral springs have been recognised from very early periods of history. The Romans, specially, brought this branch of science to a great perfection. Pliny divides the mineral waters into acidulous, saline, nitrous, aluminous, and bituminous; and indicates the uses of each. There is not a great difference between this classification and that adopted at the present day. He further remarks, albeit with some exaggeration, that «the Romans found themselves so well with the use of baths that they did not require any other medicine during six hundred years» (1). There is no doubt that a simple daily bath would be one of the means of diminishing among the poor a good many diseases, especially of the skin.

Almost all the important Portuguese baths and mineral waters at present in use were well known to the Romans. Some of them fell into oblivion since quite recently; one of them, St. Vincent in the district of Oporto, was rediscovered only in 1901. The Roman baths were neglected or destroyed by the barbarians. The friars took no notice of them, for they valued the cleanliness of the soul at the expense of the cleanliness of the body.

There is no quite satisfactory classification of mineral waters. Their classification upon geographical or geological basis is of no practical importance. Usually they are classified either according to their physical properties and chemical composition, or according to their physiological effects and therapeutic uses.

Rotureau divides mineral waters according to their temperatures into mesothermal, or the ordinary temperature of baths, 33°.8, the mean temperature of the air being 15°; hyperthermal or hot, or those which have a higher temperature than 33°.8; hypothermal or warm, those from 33°.8 to 25°; protothermal or tepid, those from 25° to 15°; and athermal or cold, those below 15° (2). This classification has to be somewhat modified when applied to the waters in Portugal. All waters which are below 18° have to be considered as cold, for the mean temperature of the air in Portugal is higher than in other countries in Europe.

When a water contains less than $0^{gm.}6$ of solid residue in a litre and is thermal, it is termed hypomineral or indifferent; when the residue is between 0.6 and $5^{gm.}$, it is mesomineral or moderately mineral; and when it exceeds $5^{gm.}$, it is hypermineral or very mineral or very saline. A simple table or aerated water is usually cold; it contains less than $0^{gm.}3$, of solid residue, and is styled protomineral or feebly mineral.

For practical purposes mineral waters according to their chemical composition may be divided into 8 classes. The following is a very brief summary of the principal characters and uses of each class.

I) The Indifferent or Simple Thermal Waters. These contain less than $0^{gm.}6$ of solid residue, which consists chiefly of bicarbonate of sodium, chloride of

sodium, and a small quantity of carbonic acid, and, sometimes, of some sulphureted hydrogen. Their temperatures vary from 20° to 98°.5. These waters are chiefly used as baths, and are seldom taken internally. They are useful in gout, rheumatism, liver complaints, skin diseases, bronchial catarrhs with scanty secretion, sciatica and other neuralgias, sleeplessness, vesical disorders, and uterine complaints. These baths are sometimes known as acratothermal.

II) Sulphurous Waters. The predominant element in these waters is sulphur, which may exist as pure sulphide of hydrogen and oxysulphide of carbon; or as sulphides of sodium, potassium, calcium or magnesium, with variable amounts of chlorides and carbonates of sodium or calcium. These waters are usually thermal, and are used both internally and externally. Their action is not well understood. Taken internally, they act as stimulants of healthy organs. Used externally, when warm, they stimulate the cutaneous function, and act as diaphoretic and alterative. They are useful in syphilis, skin diseases, especially prurigo, urticaria, acne, and psoriasis; chronic metallic poisoning; asthma, chronic catarrh of the alimentary canal and of the respiratory system; chronic gout and rheumatism; paralysis and locomotor ataxy; and in some uterine disorders. If the baths be strong, they are liable to cause considerable irritation of the skin.

III) Common Salt or Muriated Waters. The main constituent of these waters is sodium chloride; the other salts present are chlorides of calcium, magnesium, and potassium. Many contain carbonic acide and small amounts of iodine and bromine. These waters are either warm or cold. When the amount of salt exceeds

1.5 per cent, they constitute *brine* baths. Weak brine baths contain 1.5 per cent to 2 per cent of salt; moderate, 2 to 6 per cent; and strong, above 6 per cent. The strong give rise to considerable irritation of skin, and have to be diluted to proper strength. Mother-lye or *Mütterlauge* of the Germans is the fluid which remains after the extraction of salt by boiling. It is added to weak saline waters to strengthen them. The sea-baths described further on belong to this class of waters. Taken internally, in small doses, the muriated waters stimulate the normal secretions and promote metabolism; in large doses, they act as laxatives or purgatives. They are useful in scrofula and rickets; catarrhs of the alimentary canal and of the respiratory organs; neuralgia and some forms of paralysis; arthritis and lithiasis; dilatation of the heart; diseases of the liver and syphilis.

When the *iodine* and the *bromine* in the muriated waters exceed a certain amount, the waters are termed iodated or bromated. These waters are especially indicated in scrofula and in syphilis.

IV) Alkaline Waters. The main bases of these waters are carbonate of soda and a considerable amount of free carbonic acid. These waters may be divided into four sub-classes:

The *alkaline* and *carbonate* or *acidulous* waters contain more than $1^{gm.}$ of bicarbonate of soda in a litre of water as the principal ingredient, with a large amount of carbonic acid. The other constituents are variable amounts of chlorides and sulphates of sodium, and minute quantities of lithia. These waters are either cold or warm. When they contain 20 volumes per cent or more of carbonic acid, they form carbonated acid baths. Taken internally, they regulate the digestive

function and increase the alkalinity of the blood and of the bile; and are useful in dyspepsia, in various catarrhs of the alimentary respiratory and urinary systems; and in diabetes and gout. As acid baths, they are useful in diseases of the heart, in various nervous disorders, and in derangements of menstruation.

The *mixed* alkaline contain, besides sodic carbonate, a large proportion of other alkaline carbonates, such as potash and magnesia; and are useful in gastric and intestinal catarrh; in jaundice and in some forms of diabetes.

The *alkaline* and *muriated* waters have the common salt as the predominant constituent, varying from $0.^{gm.}15$ to 4.6 per litre. They are warm or cold. They are largely used as gargles and inhalations; and are especially indicated in the first stage of pulmonary tuberculosis and chronic gastric catarrh.

When the alkaline waters contain a considerable quantity of lithia, they are termed *lithiated* waters. They are useful especially in lithiasis and allied disorders.

V) Bitter or Sulphated Waters. These contain a considerable amount of sulphates of sodium and magnesium, in addition to variable quantities of carbonates and chlorides of sodium, calcium and magnesium, with sometimes some free carbonic acid. They are always cold. Their chief action is laxative or purgative according to the quantity of water consumed. They are indicated in constipation, liver complaints, obesity, and some forms of diabetes. They are not taken, as a rule, at the source. They are largely used in habitual constipation.

VI) Earthy or Lime Waters. These are characterised by large quantities of the salts of calcium and magnesium,

chiefly in the forms of sulphates or carbonates; sometimes they contain free carbonic acid or free nitrogen. They are warm or cold. Taken internally, the carbonates of calcium and magnesium diminish the secretion of the digestive, respiratory and urinary organs. The cold water containing carbonate of lime with carbonic acid are diuretic. These waters are useful in chronic catarrhs of the stomach and the intestines, in some liver and pulmonary complaints, in chronic gonorrhea, in some skin diseases, in scrofula, rickets and osteomalacia, in gout, in diabetes, and in anaemia and chlorosis.

VII) IRON OR CHALYBEATE WATERS. The principal constituent of these waters is iron in the shape of carbonate or sulphate, forming carbonated iron waters and sulphated iron waters. Sometimes the iron exists in the form of phosphates. A water is termed chalybeate when it contains 1 to $20^{cgm.}$ of iron salts in 1 litre of water. The carbonated iron waters when they contain an excess of carbonic acid are more easily digested than the sulphated. These waters are usually cold. They are used both internally and externally. Taken internally, they act as reconstituent and tonic. Those waters which contain a considerable amount of carbonic acid are used as iron-baths. They are largely employed in anaemia, chlorosis, debility, malarial cachexia, atonic dyspepsia, chronic diarrhoea, hysteria, hypochondriasis, and sexual debility.

VIII) SIMPLE AERATED OR TABLE WATERS. These are also known as carbonated, acidulated or gaseous waters; they contain a large amount of carbonic acid, more than $500^{c.cm.}$ in $1000^{c.cm.}$, of water. The solid constituents are less than $0.^{gm.}3$, and consist chiefly of bicarbonates

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of sodium and of calcium. These waters are cold. Taken internally, they are gentle stimulants of the digestive, circulatory and nervous systems. They are used plain or mixed with wines or spirits. Some mineral waters containing a large amount of salts are used by thoughtless persons as table waters. This is a great mistake.

Some of the eight classes of waters may be further modified by the presence of various other mineral substances, such as *arsenic, fluorine,* and *silica;* and of various *radioactive* emanations, and of some rare gases, as helium, argon, neon, crypton, and xenon.

As regards the *physiological effects* and *therapeutic uses,* mineral waters are *classified* like ordinary drugs. The indifferent and the sulphureous waters are, generally speaking, abluent and alterative; the muriated are stimulant of the healthy organs and of the intestinal tract; the alkaline are stomachic and diuretic; the bitter are laxative or aperient; the earthy and the chalybeate are tonic and reconstituent; and the table waters are mildly stomachic and diuretic. Waters containing lithia, iodine, bromine, arsenic, fluorine, silica and radioactive substances have the special action due to these ingredients.

The action of the radioactive emanations has attracted a good deal of attention during the last few years. There is always a tendency to attribute all sorts of properties to any newly discovered substances. It is necessary to wait some more years to see what is their exact action. At present they are supposed to have no perceptible action in healthy persons; but in some morbid conditions, such as produced by rheumatism, they give rise to a definite reaction, producing ultimately

a decrease of pain and of swelling of the joints. They are also useful in sciatica and ulcers.

The action of the quantity of water taken *internally* depends upon the solid constituents. The beneficial effects are influenced greatly by the frequency and regularity with which the waters are taken.

There is yet no quite satisfactory explanation as regards the exact action of mineral waters taken internally. The action of these waters does not depend only upon the amount of mineral substances they contain. Antyllus noticed long ago that «the action of mineral waters is much more efficacious and energetic than that of the artificial waters» (3). Some attribute it to the combination of several substances chemically different, others mainly to the electrical powers; some to the ionisation, and others to the radioactive emanations. The fact is, to obtain the full benefit of many of the mineral waters it is necessary to take them at the source; and it is likewise a fact that the climate, and the regimen as regards food, drink and exercise followed at the various resorts, contribute their share to the cure. Generally speaking, all waters stimulate the action of the diseased organs and promote metabolism.

The mineral waters are used *externally* as baths. The term bath includes all forms of external application: simple immersion baths, swimming baths, and general and local douches; it also includes all local applications, such as gargles, injections, irrigations, inhalations and pulvarisations. A bath, as regards its temperature, is said to be normal (34°-35°), warm (35°-38°.8), hot (above 38°.8), tepid 38°.8-25°), cool (25°-15°), or cold (below 15°). The Romans recommended a bath of

$^1/_2$ hour increased to 2 to 2 $^1/_2$ hours at the end of the first week, and gradually decreased in the third week again to $^1/_2$ hour. At present the usual duration of a bath is about $^1/_2$ hour.

The external use of mineral waters is in many respects similar to that of ordinary water. Its special action is due to the chemical, electric and thermal stimulation of the skin, and not to the absorption of mineral substances. Its action is both direct and reflex. The direct influences the cutaneous nerves and vessels, accelerating the circulation of blood and of lymphatic fluid; and the reflex promotes the functional activity of the circulatory, respiratory and urinary systems, giving rise to increased metabolism.

Persons undergoing treatment by mineral waters have to pay particular attention to their diet, specially if they suffer from the derangement of the digestive organs. The German physicians are very exacting in this respect, and it would be a good thing if others would follow their example.

All the spas are usually frequented from May to September; only a few are utilised during the whole year. The Romans recommended the spring and the autumn as the most appropriate seasons for balneotherapy. These are exactly the seasons during which the inhabitants in the cold belt should take their baths in Portugal.

The registered *number of spas,* or those which are explored, are about 73, and there are about 60 more which remain to be explored. Out of the total only 17 have been selected for a short description in these pages, some for their special medicinal uses, and others for some particular reason, such as the climate or the

accommodation. Some spas, not included among the 17, are in great favour with the inhabitants of the country and with Spaniards, but they have no particular interest to the British, or other foreigners. The districts which contain the largest number of the registered sources are Lisbon (17), Vila Rial (9), and Braga (8); those containing the lowest number are Guarda, Portalegre, and Faro, only one each.

The spas have received at the hands of medical men much more attention than the climatic resorts, but still a good deal of more work is necessary to determine and differentiate accurately the uses of some of the sources as compared with some others of the same class. Besides some valuable monographs on particular sources, there are, among others, two books which give a good summary description of the principal baths and mineral springs of Portugal: one by Dr. Lopes (4), and the other by Dr. Sarzedas (5). From the historical point of view the work of Dr. Fonseca Henriques (6) is worthy of note.

Compared with other countries of the same size, Portugal and the adjacent islands present not only more sources, but also a greater variety. Some of the waters are not known in other European countries, but have a well deserved reputation in South America.

In order to simplify the description of spas, the characters of only the principal source have been specified.

4. SEA-BATHING RESORTS.

The use of sea-baths was well-known to the ancients. Herodotus, the physician and disciple of Agathinus,

gives an excellent description of the physiological action and of the therapeutic uses of these baths. He notices why swimming is useful, and recommends an ablution of fresh water after a bath of sea-water (1).

The Romans had in Portugal a fashionable sea-bathing resort with a thermal establishment at what is commonly known as Troia, opposite to Setubal. The number of sea-bathing stations at present in use is both numerous and important.

The sea-water is similar in composition to the muriated spas, but in its uses and effects it has some distinctive characters. Its action is influenced not only by its composition, but also by its natural temperature, by its dynamic action, and by the climate of the open air.

The composition of water in the open sea is uniform; it contains in 1000 parts:

Chlorine	19.930
Bromine	0.070
SO_4	2.777
CO_3	0.075
Sodium	11.055
Magnesium	1.353
Calcium	0.432
Potassium	0.399
Total	36.091

The specific gravity of salt-water varies from 1.027 to 1.028, and the mean amount of total solids from 3 to 4 per cent. Besides chloride of sodium it contains chlorides and sulphates of potassium, magnesium and calcium; and salts of iodine and bromine. In summer the composition is nearly constant, but in winter it

varies considerably in some parts, especially near the mouths of rivers.

The temperature of the surface of the ocean varies greatly according to localities and seasons. The lowest temperature at which baths may be taken with comfort by ordinary healthy persons is 15°.

The dynamic action of sea-baths depends upon the size and the force of waves. At some places there are hardly any waves, at others they are very high and very strong.

The climate which is favourable for bathing is that in which the temperature in the open air is not below 25°, the winds are moderate, and there is good sunshine.

The action of sea-baths cannot be dissociated from the action of the sea-climate, for a person who takes sea-baths resides, as a rule, near the sea. When properly taken, sea-baths act as tonic and stimulant; and are beneficial in scrofula, neuralgia, neurasthenia, neurotic dyspepsia and some cases of hysteria. They are dangerous in persons with a weak heart. The popular notion that sea-bathing can do no harm is dangerous. The artificially warmed baths are particularly useful in weak and anaemic persons. The differences in the effects of baths at different resorts, if any, have not yet received any attention.

The action of sea-baths ought to be always stimulant. The elements which favour stimulation are: a low temperature of water, a high specific gravity, strong waves and a temperate climate with moderate winds. Their action is gently stimulant or almost sedative under the following conditions: a warm temperature of the water, a very low specific gravity, no waves, and a hot climate with no winds.

A sea-side residence with sea-bathing in summer and in early autumn, when limited to a few days, is more beneficial on a shore exposed to the north than on one exposed to the south, for in the former season the prevalent winds are from the north.

Many frequenters of spas consider a change to the seashore and a course of sea-baths as complementary to their treatment.

In England, the sea-water is sometimes used internally. Dr. Buchan describes fully the internal use of sea-water. In large doses it acts as a purgative, and in small doses as an alterative. It is useful, he says, in round worms, fistula in ano, scrofula, cutaneous diseases, jaundice, atrophy of children and, occasionally, in gravel (2).

One of the most frequent mistakes made in the use of sea-baths is to take them too long.

The sea-baths are taken chiefly in summer and in early autumn. When the temperature of the water and the climatic conditions are favourable, they can be taken in other seasons.

Compared with the Mediterranean Sea, the water of the Atlantic Ocean is less blue and the total solid residue is less. According to Buchanan «the coefficient which expresses the relation between the salinity and the *alkalinity* of the two oceans is greater in the Atlantic (0,5000) than in the Mediterranean (0,4875): the difference is not great but it is quite definite» (3).

The main characteristics of the Lusitanian sea are: large waves, total solids 3.7 per cent.; of the Mediterranean Sea, no waves, solids 3.2 to 4.1 per cent.; and of the North Sea, large waves, solids 3.1 to 3.4 per cent.

Owing to the large waves, the Portuguese sea-side resorts on the Atlantic coast are much more agreeable than those on the Mediterranean coast of France and Italy.

5. ADJUNCTS TO GOOD HEALTH RESORTS.

A good resort should be situated in a pleasant locality, with agreeable and healthy surroundings. Many resorts owe their reputation not only to their climates, good mineral springs and comfortable hotels, but also to the picturesqueness of their scenery, well-kept woods and gardens, beautiful lakes, snow-topped mountains, the proximity of large towns, the number and nature of excursions that can be made, the facilities for boating, fishing or mountaineering, and even to some historical monuments.

A health resort has to be laid out carefully. It is sometimes disappointing to see how a good climate is not taken advantage of simply by not studying carefully the way of laying out the streets, and in deciding even which side a hotel should face! The Greeks, the Romans, and the Egyptians had better notions on sanitary engeneering than some of the modern architects and municipal authorities. Vitruvius, for instance, gives definite directions for the selection of sites, and for the examination of the waters, and of the climates of those places chosen «principally for building temples in honour of Esculapius, of Health, and of other divinities to whom is attributed the power of healing diseases» (1); or, in other words, of places chosen for sanitariums. But, at present, at some places everything is left to mere chance. As a general rule, it may be laid down that

in the distribution of apartments coolness and ventilation should be kept in view in the country below the valley of the Tagus, whereas warmth and protection from cold should be the aim in the country above it.

The health resorts should be easily accessible. To those who are not sea-sick a sea-voyage is preferable to a railway journey. In all cases there should be no vexation regarding customs and octroi. Good shelters and waiting rooms should be provided at the landing places, and at the principal centres of omnibuses in a town. There should be good waiting rooms with good seats at the principal railway stations.

The postal service should be rapid, regular and punctual; and the parcels should be delivered within a reasonable period. The sanitary arrangements at the railway stations should be good; and the railway restaurants should be clean and tidy. The fares for carriage drives should be reasonable.

At a good health resort there should be, if possible, hotels for all classes of people or for all purses. The essential requirements of a good hotel for the middle classes, who always furnish the largest percentage of visitors, are: thorough cleanliness of rooms with a soft bed, perfect sanitary arrangements, pure water supply, and wholesome food. All noises are to be avoided both inside and outside hotels. If children be admitted, they should be provided with playrooms or other suitable accommodation. It is curious that in Portuguese there is no word for «nursery». In Portugal some children dominate not only their parents, but are allowed to dominate all the guests at some of the small provincial hotels. They are allowed to do just what they like. This is a great nuisance to almost

all foreigners. Another defect is that servants are allowed to loiter on the staircases, where they chatter and laugh as if they were in open fields. It may be noted, however, that things are mending slowly. In cooking food, it is essential to use fresh butter and when necessary good lard, but never any suet or oils. All highly seasoned dishes should be avoided. Garlic should not be used at all, and onions only sparingly. It is interesting to see how the old Lusitanians, as described by Strabo (Ch. X. 2), used butter instead of oil in their cookery. It would be well if the proprietors of many of the small provincial hotels return to this old and wholesome habit. Butter may not be agreeable to some palates, but oil upsets the digestion of those not accustomed to it. If all the Portuguese and other visitors of hotels would point out, in a friendly spirit, all the defects they notice, there would at once be an improvement all round, for the defects are due, often, more to ignorance than to any other cause. Some of the hotels sacrifice comfort to external appearances. This is a great mistake. What all visitors require is real comfort in their rooms or apartments. It is needless to state that the large first class hotels are just as good, if not superior in some respects, to similar establishments elsewhere. In justice to the smaller hotels, it is necessary to mention two facts in their favour: the first is that their proprietors are invariably most obliging and willing to do anything in their power for the comfort of their guests; and the second is that the food they supply is always abundant, and that there is never any sign of stinginess. A good hotel should be provided with some means for amusement.

A good set of books is always welcome; so is a good billiard table. A lawn-tennis and a croquet ground are always useful.

All the surroundings of a health resort should be rendered as agreeable as possible. There should be good roads and good foot-paths all round, with benches at suitable places for rest. The roads should be made in such a way as to reduce the dust to a minimum. There should be always at least one good public garden or park. Social and intellectual amusements should be provided according to requirements. The special requirements of each class of visitors should be studied. At present no pleasure resort is favoured by any British tourist which does not possess good golf-links. A well regulated casino with good music is appreciated by all.

The general drainage of a health resort should be perfect, and the water supply good and abundant. The sanitary condition of many of the places described in the following pages has been studied by Dr. Montenegro(2). Compared with England, there is no doubt that Portugal as a whole lags behind; but compared with other Latin countries, there is no difference, or hardly any difference. As a guarantee to foreigners, all hotels should be required to furnish a certificate of the government Health Officer of the District stating that the sanitary arrangements are in good working order, and that the water supply is pure. There is a law to this effect, but it is seldom put into practise.

The public health of a health resort should be irreproachable. All measures should be taken to do away with mosquitoes and house flies. The presence

of a large number of house flies is a sure sign that the place is not clean.

Many persons of means readily invest their money in Portugal in building hotels at any spa; but they do not show the same alacrity in building hotels for the sake of climate. It seems to me that it would be more advantageous to build hotels at certain select spots with a good climate, for such hotels would be frequented in two seasons; in summer by the Portuguese, and in winter by the foreigners. Another idea which has not yet taken root is for one class of people to build hotels, and another class to rent them and manage them. A well-built and well-placed hotel in a town is a better investment at present than a house with flats to let. The building must be adapted to the requirements of persons of moderate means.

In the following six chapters the health resorts are grouped according to the regions in which they are situated, for by this means an idea can be formed of the climate which may be expected at each place, and also of the nature of the spas.

A work entitled Art and Nature in Portugal (3) gives excellent illustrations of many of the resorts described in these pages.

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CHAPTER XIV.

HEALTH RESORTS IN THE NORTH ATLANTIC REGION.

Climate: cold and moderately moist in winter; warm and moderately dry in summer.

Spas: bicarbonated, and sulphureous.

The general characters and therapeutic uses of the various resorts depend upon the class, the species, and the type of climate to which they belong, and can be easily made out from the description given in Chapters IX. and XIII. Only the special uses, if any, are noticed in the description of each resort in this and in the following chapters.

A. CLIMATIC RESORTS.

The principal climatic resorts in the North Atlantic region are: Viana do Castelo, Oporto, Bom Jesus do Monte, and Seixoso, in the climatic subregion Entre Douro e Minho; Granja and Espinho, and Figueira da Foz, in Beira Mar; and Coimbra, and Bussaco, in Beira Alta. It may be mentioned, once more, that the boundaries of the climatic subregions do not

correspond always with the boundaries of the Provinces. The subregion Minho is sometimes styled the «Summer Garden of Portugal». Virchow, the famous pathologist and anthropologist, who made as excursion to Braga in September, 1880, in describing the region says: «He who has travelled during weeks on the burning plains and bare mountains, devoid almost of any trace of vegetation, experiences an intense pleasure in finding himself suddenly in a country so charming, so rich, so cool, and so green... There is in this province such an exhuberation of vegetation that I could not mention any other place similar to it among the countries visited by me in Europe» (1). He then proceeds to explain why it is so.

The capitals of the districts in this region not included among the health resorts are: Braga, Aveiro, and Vizeu. Braga, 200 m. above the level of the sea, is a very ancient city, famous for its cathedral. Aveiro, 10 m., situated on both sides of the Ria or the Lagoon of Aveiro, and near the estuary of the Vouga, has been styled the «Lusitanian Venice»; it was formerly a port of considerable importance. Vizeu, 540 m., is situated on a hillock between the rivers Dão and Vouga, and is dominated by its cathedral, which is famous for its architecture and its pictures.

1. VIANA DO CASTELO.

Marine, littoral and riparian. Winter: moderately cold and moist, very saline. Summer: warm and feebly dry, saline.

For the sake brevity the word «temperate» is omitted in this and in the following head-notes after

the words *warm, moderately warm, cool,* and *moderatly cool.*

· Viana do Castelo, so named after a castle built in 1253 to defend against foreign invasion, is the capital of the district of the same name. It is known as the «Pearl of the North» on account of its beautiful aspect. It is situated in 41° 42′ N. lat., and 85 km. by rail from Oporto, on the right bank of the Lima and on the coast, partly on a low plain and partly on the gentle slopes of a hillock, among healthy surroundings, for there are no marshes in its vicinity. It consists of 2,235 households with 10,490 inhabitants. On its eastern side, it is dominated by the beautiful hill of Santa Luzia (553 m.), a prolongation of the Serra of Arga, commanding a charming view of the city and its surroundings. It is said that the Romans had on this hill a city known as «Cividade». The friars had a monastery on its slopes.

The climate of Viana is, like the subregion Minho, under the influences of the south-west winds in winter, and to some extent in summer, which render its climate very saline in the former, and saline in the latter. It is moderately cold and moist in winter, and warm and feebly dry in summer. The soil is partly tertiary; the water supply is good and pure, 43.34 l. per inhabitant. The scenery all along the Lima is charming. The Lima was known in the time of Strabo as Lethe or the Oblivion.

Viana offers a good and healthy littoral climate from late spring to early autumn. The hill of Sta. Luzia could be converted into one of the most attractive summer resorts. It has an excellent water-supply, a good road, and a large building which was intended

to be a hotel. Viana forms a good centre for several very interesting excursions. Viana (from Lat. *vinea*) had formerly a large and important wine and fishing trade, and it was in this city that the British had their first colony or community in Portugal.

2. OPORTO.

Urban, marine, littoral and riparian hills, most temperate, fluctuation moderate, range equable. Winter: moderately cold and moist, very saline, rainfall excessive, evaporation moderate. Summer: warm and feebly moist, saline, rainfall scanty, evaporation feeble.

Oporto or «The Port», the second city of Portugal and the capital of the North, is situated partly on the coast and partly on the Douro, in 41°, 8′ 6″ N. lat. It is supposed to consist, like some other cities, of seven hills; its highest point of elevation is 160 m. For climatic purposes it may be divided into three parts: the main portion of the city on the right bank of the Douro; the Vila Nova de Gaia, on the left bank; and the narrow and low portion of Foz, Vilarinha, and Matozinhos, on the sea coast. Both the banks of the river consist of steep rocks of granite. The city is decidedly picturesque, and certainly more Portuguese in the manners and the customs of the inhabitants than Lisbon. It has 42,890 households with a population of 194,010. It contains several open places and gardens, the most important of which are the park of the Crystal Palace, the Campo dos Martires da Patria, and the garden of St. Lazarus in front of the National Library.

The mean temperature in winter is 9°.08, in spring 13°.66, in summer 19°.59, and in autumn 14°.96. The means of the maxima and the minima for the four seasons are: 13°.17 and 5°.86; 17°.43 and 9°.90; 25°.39 and 15°.72; and 17°.43 and 11°.44. The evaporation in winter is 155^{mm} and in summer 251, and the relative humidity is 80.7 and 74.9, respectively. The rainfall is 477^{mm}.5 in winter; 291.4 in spring, 121.1 in summer, and 343.4 in autumn; total 1233^{mm}.6. The mean number of days of rainfall is 158. Mists are frequent; they are 19.5 days in winter, and 16.6, 20.3 and 24.5 in the three other seasons. The mean number of days of snowfall during the year is 19.1. The mean number of hours of sunshine in December is 123, and in winter 455. The climate of Oporto is changeable. The best and the healthiest months of the year are May, June, and April; and the worst are October, September and January (1). The difference in temperature between sun and shade is greater than in Lisbon.

Owing to the evercrowding and the poverty of the population, the sanitary condition is not good. The death rate is 31.2 per mille. The water supply is good, but insufficient, only 14 litres per inhabitant. A complete modern system of drainage is being laid out, which, when completed, will no doubt improve the public health. There is a great similarity in the climates of Oporto and Barcelona, but the annual fluctuation in the former is 10°.75 less, which is due to influence of the Gulf Stream.

Oporto is of great interest as a pleasure resort. The English colony of the city dates from 1654, and the English factory from 1786. The healthiest part

of the town is San João da Foz, formerly the property of the Benedictine Friars of St. Thirso. Many people go there, and to Matozinhos, for a change of air. It has a casino, and a golf course.

The most important places in the environs of Oporto, from the climatic point of view, are Povoa de Varzim towards the north-west; and Granja and Espinho towards the south.

3. BOM JESUS DO MONTE.

Marine, inland-hill, sylvan. Winter: cold and moist. Summer: moderately warm and feebly moist.

This place, also known as Bom Jesus de Braga, is in the district of Braga. It is famous for its old sanctuary and for its beautiful situation. It lies in 41°.33′ N. lat., and at a distance of 25 km. in a direct line from the sea. It is situated about midway or at an elevation of 400 m. on the western slopes of Monte Espinho, and at a distance of 2 ½ km. to the east of the city of Braga. Although not very far from the coast still it is not well exposed to sea-breezes. It has good gardens, and several pleasant walks in the woods near by. The top of the hill presents a fine view of the surrounding country. The town of Braga is 57 km. by rail from Oporto, and there is a funiculaire leading to the Monte.

Owing to the favourable position and to the woods the climate is moderately warm and feebly moist in summer; it is very healthy. The water supply is good.

Bom Jesus is the most frequented inland resort of

Minho. It is chiefly used by the people in the north as a place of rest and repose after a cure at a spa or at the sea-shore. Its special medical uses, if any, are not known. It forms a good centre for several interesting excursions.

4. SEIXOSO.

Marine, inland-highland, sylvan. Summer: moderately hot and dry.

This is a place at Lixa, an important village in the Serra of Seixoso, in the district of Oporto, and at a distance of 22 km. from Cahide. It is sheltered from the north and the east winds, and is exposed to the south. It has the best residential hydropathic establishment in Portugal, which is situated at an elevation of 500 m., and at a distance of 45 km. from the sea. The soil is dry, and there are good woods consisting chiefly of pines and of eucalyptuses.

The climate is dry, and healthy. The mean temperature in summer is 22°. The water suply is excellent, yielding a solid residue $0^{gm}.0362$; it is supposed to possess some diuretic properties. The air is free from dust, balmy and pure.

The sanitarium is devoted to the treatment of anaemia, gout and diabetes; and some diseases of the circulatory, digestive and nervous systems. It is also a place for the grape and milk cures. No consumptives are admitted. A railway line is being made from Penafiel to Seixoso; its length is 32 km. The proprietor of the sanitarium is Dr. A. Cerqueira Magro.

5. GRANJA AND ESPINHO.

Marine, littoral lowland. Summer: warm and feebly moist, saline.

Granja and Espinho are two contiguous places in the district of Aveiro, 15 km. by rail to the south of Oporto. Granja, which dates only from 1854, is the most fashionable seaside resort in the north; and Espinho is more in favour with the middle classes. Both of them suffer from the encroachment of the sea. Their soil is sandy and there are several dunes. Near Granja there are good pine woods. In summer the climate is rendered mild by the full exposure of the two stations to sea-winds and sea-breezes; in winter it is strongly saline. The water supply and the public health are good.

Both the places are largely freguented in summer for rest and for sea-bathing. They are beneficial in anaemia and scrofula. Espinho has a golf club.

6. FIGUEIRA DA FOZ.

Marine, littoral and riparian lowland, saline. Winter: cool and feebly dry, rainfall very moderate. Summer: moderately hot and dry, rainfall very scanty.

This town forms the chief seaport of the district of Coimbra, and is situated partly on the right bank of the Mondego, and party on the coast, in 40°.9′ N. lat. and at 220 km. by rail from Lisbon. Its mean elevation is about 10 m. and its soil is sandy. It is partially sheltered on the north-east by the Serra of

Buarcos. The number of inhabitants is 6,930, and of households, 1,600.

The climate is healthy. The mean temperature in summer is 22°.8 and in winter 13°.8 (?). The mean of rainfall in summer is $67^{mm}.88$, and in winter, $268^{mm}.20$. The water supply is good and abundant, 66 l. per head. The temperature in winter requires confirmation. I have classified the station as cool.

This station is very largely frequented in summer; it is in great favour with the Spaniards of the provinces of Leon and Estremadura. It can be utilised as a winter resort. It has two casinos. It is on the coast of the commune of Figueira that Wellington landed 1,300 troops in 1808. In olden times Figueira formed the principal port of Portugal.

7. COIMBRA.

Marine, inland-hill, partly lowland and riparian, most temperate, fluctuation very moderate, range equable. Winter: moderately cold and feebly moist, rainfall very moderate, evaporation excessive. Summer: warm and dry, rainfall scanty, evaporation excessive.

Coimbra, the capital of the district of Coimbra, and till 1911 the only university town in Portugal, is situated in 40°12′30″ N. lat., in the enchanting valley of the Mondego, and at a distance of 38.5 km. from the sea. There is no place the praises of which have been so frequently, so largely, and so deservedly sung, as that of Coimbra:

Coimbra, terra d'encanto,
Do Mondego alegre flor...

«Coimbra, the land of enchantment, the beautiful flower of the Mondego». The principal or the main portion of the city lies on the right bank of the river, on the rather steep slopes of a spur of the Serra of Lorvão rising to a height of 125 m. On the western bank rises the Monte de Esperança with the famous Quinta das Lagrimas (Villa of Tears) and Fonte de Amores (Fountain of Love). The portion of the town which lies on the borders of the river is known as the Baixa or the Low Town; is has a mean elevation of 5 to 6 m. above the mean level of the river. The population is 20,580 and the number of households, 4,590. The soil is dry; and the vegetation is abundant. There is an excellent plantation of the black poplar.

The climate of Coimbra is most temperate. The mean temperature in winter is $9^{\circ}.66$, in spring $13^{\circ}.58$, in summer $19^{\circ}.90$ and in autumn $15^{\circ}.59$. The means of the maxima and of minima in the four seasons are: $13^{\circ}.22$ and $6^{\circ}.08$; $19^{\circ}.34$ and $9^{\circ}.65$; $27^{\circ}.16$ and $15^{\circ}.26$; and $20^{\circ}.54$ and $11^{\circ}.5$. The evaporation in winter is 313^{mm} and in summer 803; and the relative humidity 75.22 and 68.79 in the two seasons, respectively. The rainfall is $255^{mm}.5$ in winter, 292.9 in spring, 79.0 in summer, and 266.6 in autumn. The mean number of days of rain is 139.8. The number of days of mist is 74.0; and of snow, 19.0. The mean number of hours of sunshine in December is 134, and in winter, 441. The N. N. W. wind brings in more rain than that from any other quarter. Although Coimbra is in a lower latitude, and more inland, its mean temperature in summer is nearly the same as that of Oporto. The mortality is lowest, according to Dr. J. Cid, in June, May and April; and highest in January, December and September (1). Diarrhoea

among children, and bronchial affections are the most frequent complaints. The malarious fevers, which were formerly prevalent, have disappeared since the building of the river embankments. The water-supply is good, about 40 l. per inhabitant.

The climate is sedative and tonic, it is at its best in spring. It is useful in neurasthenia and some other nervous affections. The city is well worthy of the attention of the tourist; it has several points of great historical and literary interest. The Monte de Esperança commands a beautiful view of the Serra of Louzã on one side, and of Bussaco on the other. The botanical gardens, which date from 1774-75, are well stocked with many exotic plants, and are worthy of a visit.

8. BUSSACO.

Marine, inland-hill, very sylvan. Winter: cold and moist. Summer: moderately warm and feebly moist.

Bussaco, one of the best and most attractive of the Portuguese health resorts, is situated in the district of Aveiro, in 40°21′6″ N. lat., at a distance of 40 km. from the sea, and of from 3 to 4 km. from the railway station of Luso. The Serra of Bussaco, which is a portion of the Serra of Caramulo, occupies an area of 400 hectars, and is enclosed in a stone wall measuring $3^{\text{km}}750$. Its highest point, the Cruz Alta or the High Cross, rises to 547 m. The hotel, a unique building of its kind, intented at first to be a royal residence, is situated among the woods at the elevation of 357 m. The soil consists chiefly of schale; and there are several springs of pure water.

Bussaco, said to be a corruption of *bosque sacro,* or

the «sacred wood», is famous for its marvellous and luxuriant vegetation, the existence of which is due in the first instance to the care and perseverance of the Benedictine Friars, who had a monastery there; and of the Carmelites later on. Pope Gregory XV. granted a bull, dated 23 July 1622, excommunicating any woman who entered the enclosure of Bussaco; and Urban VIII. issued another, dated 28th March 1645, applying the same penalty to anybody who cut down or caused any harm to trees belonging to the monastery. Both the bulls, inscribed on marble tablets, are placed at the Coimbra Gates, formerly the main entrance to the domain.

Among the most important old trees which form the woods are the cypresses (*Cupressus lusitanica,* erroneously termed the Goa or Bussaco cedar), the oaks, the chestnuts and the pines. A tree that thrives well is the camphor cinnamon (*Cinnamomum camphora).* Within the last few years the woods have been enriched with many other specimens of the exotic and the indigenous floras.

The climate of Bussaco is mildly warm, and moderately and pleasantly moist in summer; and cold, and moist in winter. It is the best Portuguese forest climate; the air is pure, light and healthy, and free from dust, which is so annoying at some other places. There is a stillness in the air which is very soothing. The tall trees break the force of the north winds, and the mountains on the east shelter it from the hot east winds in summer, and the cold winds in winter. It snows as at Coimbra, but the mists are more frequent. The water supply is pure and abundant and the drainage is good.

The strong and the healthy can visit Bussaco in all seasons; but the invalid must avoid it in winter. The favourite season with the English is late winter and spring; and with the Portuguese the summer. The climate is tonic and sedative in summer; it is useful in dry chronic bronchial affections; in anaemia and convalescence from acute diseases; and in neurasthenia and some other nervous affections. It must be avoided in winter by the rheumatic and the gouty. To the residents of Lisbon and Oporto, it is a far more desirable place for a change of air than either Cintra or Bom Jesus do Monte, for it is further removed from the sea influence. To the English tourist it has a special interest, owing to the battle of Bussaco fought on the 27th September, 1810, by the Anglo-Portuguese army under the command of Wellington. It forms a good centre for many pleasant excursions. The Cruz Alta commands a good view of the Serra of Estrela. This resort is susceptible of great development. The present hotel was built as a summer residence and is placed among woods. A hotel and some villas on the outskirts of the forest, as at the Gates of Coimbra, would be very useful, for they could be utilised by the invalid throughout the whole year. The baths of Luso, described further on, are within reach of the hotel at Bussaco.

B. SPAS.

The most important spas in the North Atlantic region are: Melgaço, Gerez, Caldelas, Vizela, and Entre-os-Rios, in the subregion Entre Douro e Minho; Curia, in Beira Mar; and Luso, in Beira Alta.

Among the other spas in this region may be mentioned the following: Monção, in the district of Viana; San Vicente, in Oporto; Amieira, in Coimbra; and Felgueiras and San Pedro do Sul, in Vizeu.

9. MELGAÇO.

Earthy, cold, moderately mineral, calcic carbonated, chalybeate, and gaseous carbonated.

This spa, the most northern in Portugal, is situated in the district of Viana do Castelo, at a distance of 1km.5 from the left border of the Minho, and of 45 km. from the sea, in a very pleasant and picturesque position, at an altitude of 70 m. above the sea-level. Its mean temperature in summer is 25°; its air is pure, and the public health is good.

These waters have come into use only since 1885, but they are gaining ground year after year. Their temperature is 15°; they are clear, inodorous and agreeable to taste. The total fixed residue is 1gm.9, composed chiefly of bicarbonates of calcium 0.9, of sodium 0.4, and of magnesium 0.2; carbonate of iron 0.05; and lithia 0.007. They contain a large quantity of free carbonic acid, 1gm.9.

Melgaço is very efficacious in some forms of diabetes; it is also useful in anaemia, chlorosis and dyspepsia. The waters are bottled for export. The dose is from 60 to 300 gm. The season lasts from 15th May to 31st October.

Monsão, an indifferent, hot, and sodic carbonated spa, is largely frequented by the Spaniards in cases of rheumatism and skin diseases. One of the bathing

establishments was originally built by Mr. Richard Allen, who was a British Consul at Viana do Castelo.

10. GEREZ.

Indifferent, hot, warm and tepid, sodic carbonated and fluorinated, azotised and oxygenated, and slightly sulphureted.

This is one of the most important spas not only of Portugal but of the whole of Europe. It is situated in the district of Braga, at a distance of 47 km. to the north-east of the city of Braga, and at an altitude of 468 m. on the slopes of the Serra of Gerez, which rises to a height of 1.433 m. At its foot runs the river Cavado. The soil is granitic and dry. The vegetation is very dense, and extremely rich in the variety of indigenous species; the most common tree is the oak. The climate in summer is warm, the mean temperature being 19°.7; in May the temperature is 12°.0, and in October 11°.2. The air is dry and pure. The mountain breezes are strong and agreeable. The drinking water is pure. The resident population is only 350.

This spa was known to the Romans. Recent excavations have brought to light coins of the time of the Emperors Gallianus and Constantius. There are several sources with temperatures varying from 48°.2 to 18°.2; the most useful is the Bica. The water of this source is clear, inodorous and pleasant to taste; its temperature is 41°.7, and its composition is as follows:

Bicarbonate of sodium................gm.	0.0875
» » potassium.................	0.0142
» » calcium....................	0.0125

Bicarbonate of lithium	0.0031
» » magnesium	0.0015
Fluoride of sodium	0.0228
Sulphate of sodium	0.0278
Chloride of sodium	0.0227
Silicate of sodium	0.0422
Silica	0.0616
Oxide of iron and aluminium	0.0001
Total	0.2960

Oxygen	1.731
Nitrogen	11.189

According to Dr. Jorge, this water contains more fluorides than any other source in Europe (1), and it is to these salts that he attributes its chief therapeutic uses. The establishment is one of the best in the country. Prof. Pinto finds Gerez to be the most radioactive waters for drinking purposes among the 9 sources which he has examined (2).

These waters are specific in liver complaints, when complicated especially with diabetes. They are used both internally and externally. They increase the appetite, produce slight relaxation of the bowels, and give rise to a large discharge of brick red deposit in the urine. They are especially useful in persons returning from the tropics, and suffering from engorgement of the liver, and cirrhosis; and from enlargement of the spleen. They are also useful in gouty and rheumatic affections. In many respects they have a great resemblance with those of Carlsbad. The season lasts from 15th May to 31st October. The waters are bottled for export. Dose 15 to 200 gm.

Gerez, owing to the mildness of the climate is useful

as a climatic resort in summer. It has good fishing and good mountaineering. The valley of Teixeira, 1000 m., presents a fine site for a sanitarium of medium altitude.

II. CALDELAS.

Indifferent, warm and tepid, calcic carbonated and very radioactive.

This spa is situated in the district of Braga, at a distance of 17 km., to the north-east of the city of Braga. It lies in the valley of Albito, at an altitude of 128 m., and on the slopes of the hill S. Pedro. The country all round is well cultivated. The mean temperature from June to November is 23°. The public health is very good.

The Romans were likewise acquainted with this spa. There are six sources, all of which have more or less the same composition. Those used for internal administration are Bica de Fora and Bica Barbosa. Their temperature varies from 32°.5 to 23°. The solid residue varies from $0^{gm}.10$ to 0.13, and consists chiefly of calcic bicarbonates. The radioactivity of these waters stands, according to Moreau (1), next to those of Badgadstein and Plombières.

These waters are used, like those of Plombières, chiefly in enteritis and other diseases of the digestive organs depending upon or accompanying rheumatism and gout. They are useful in haemorrhoidal affections and in some skin diseases.

12. VIZELA AND TAIPAS.

Vizela is *indifferent, hot, tepid and cold, sulphureted and sodic carbonated.*

This spa, the Harrogate of Portugal, is situated also in the district of Braga, 6 to 7 km. to the south of Guimarães, amid beautiful surroundings, on the borders of the rivulet Vizela, an affluent of the Ave. The vegetation consists of a good many oaks and chestnut trees, not to mention many vineyards. The climate in summer is hot and very dry.

The Romans, who were well acquainted with these waters, considered them to be one of the best of their kind. There are more than 50 sources with temperatures from 65° to 15°; the most important of which are Mourisco on the left border of the Vizela, and Lameiro on the right border. These waters are clear and strongly sulphureted; the temperature of the source Lameiro is 65°. According to Dr. Lourenço's analysis 1000 gm. of Lameiro contains 0.^{gm}00913 of sulphureted hydrogen; and of Mourisco, 0.00862. The former yields solid residue of 0.^{gm}34; and the latter 0.33, consisting chiefly of alkaline carbonates and sulphates. The establishment is one of the best.

This spa is very valuable in rheumatism and syphilis. It is also useful in scrofula, catarrh of the larynx and the lungs, and in skin diseases. The waters are employed both internally and externally. The establishment is open throughout the year. The station has a good park and excellent walks.

Taipas is *indifferent, warm and sulphureted.*

It is situated to the north-west of Guimarães, on the

right bank of the Ave, at a distance of about 7 km. from Guimarães and from Braga. It was likewise explored by the Romans. There are four sources; their temperature varies from 32° to 28°; and their composition is nearly the same as that of Vizela but more sulphureted. They have a well established reputation in skin diseases. The season lasts from 1st May to 30th November.

13. ENTRE-OS-RIOS.

Indifferent, slightly tepid and cold, sodic sulphided and sulphureted.

Entre-os-Rios, so named on account of its situation between the Douro and its affluent the Tamega, lies in the district of Oporto, and at a distance of 16 km. to the south-east of the city of Oporto, and at an altitude of 200 m. above the sea-level. The climate is hot and dry, but very healthy; the environs are agreeable.

There are four groups of sources, the most important of which is that of the Torre or «Tower». The water of all the sources is clear and transparent, with a strong smell and taste of sulphureted hydrogen; the temperature of the Torre is 17°.5, and of the other sources from 18°.5 to 13°.5. The amount of sulphureted hydrogen in the water of the Torre, according to Dr. Lourenço, is $0^{gm}0018$ in 1000. Its total solid residue, $0^{gm}43$, consists of sulphide of sodium and ammonium; of alkaline carbonates and chlorides, and of lithia 0.002. The thermal establishment is very good. There is a hall for gymnastics.

The waters are chiefly used in diseases of the respiratory organs and in rheumatism. Their action

is similar to that of the spas of Cauterets and Luchon. They are used both internally and externally; and there are special arrangements for the use of mud-baths. There are good walks, and excellent boating. The season lasts from 1st June to 15th October. The waters are bottled for export; their dose is 100 to 150gm.

San Vicente, an indifferent, slightly tepid and sulphureted source, is utilised in the treatment of pulmonary complaints and of rheumatism.

14. CURIA.

Earthy, moderately mineral, somewhat tepid, calcic sulphated, and chalybeate.

Curia is situated in the district of Aveiro, at a distance of 96 km. by rail from Oporto. It lies in a fertile and well cultivated region. The climate in summer is moderately hot and dry.

This spa has come rapidly into favour since 1902. There are three sources, all of which have nearly the same composition. The waters are clear, inodorous and saline to taste; their temperature varies from 19°.75 to 18°.4. The principal source yields in 1000gms. of water, a residue of 2gm.4, consisting of calcic sulphate 1gm., sodic bicarbonate, carbonate of iron 0.01, and lithia 0.002.

Curia is very efficacious in gout and in uric acid diathesis. The season lasts from 15th May to 30th October. The waters are bottled for export. Dose 100 to 150gm. These waters bear a great resemblance, both in composition and uses, to those of Contrexéville.

15. LUSO.

Indifferent, warm, sodic muriated, and gaseous carbonated.

Luso is situated in the district of Aveiro, on the western slopes of the Serra of Bussaco, at an elevation of 200 m. above the sea-level. These waters can be frequented from Bussaco, the distance between the Hotel of Bussaco and the Bathing Establishment being about 2 km. Luso is well drained and healthy. The climate is warmer and drier than that of Bussaco.

These waters have come into use since the middle of the last century. They flow from the carboniferous rocks of Bussaco; they are clear, inodorous and insipid; their temperature is $27^{0}.5$. The fixed residue in $1000^{gm.}$ is $0^{gm.}047$, composed mainly of chloride of sodium, with a considerable quantity of free carbonic acid, 0.063.

This spa is useful in albuminuria, and in rheumatism and gout. It is recommended also in some diseases of the skin and of the digestive organs. The waters are used both internally and externally. They are also bottled; dose 100 to $150^{gm.}$. The season lasts from 1st May to 31st October.

Amieira, a tepid, moderately mineral and sodic muriated spa is largely frequented by those suffering from diseases of the stomach and of the skin.

Felgueira has hot, tepid and cold sources, all indifferent and sodic carbonated, useful in rheumatism and gout.

San Pedro do Sul has hot, indifferent and sulphureted sources, useful in diseases of nerves, and in gravel.

C. SEA-BATHING RESORTS.

16. SEA-BATHING RESORTS IN THE N. ATLANTIC REGION.

Viana do Castelo, Foz (Oporto), Granja, Espinho, and Figueira da Foz, already described under the climatic resorts, are largely used also for sea-bathing purposes. Besides these, Povoa do Varzim is very popular among certain classes; and Leça da Palmeira is a favourite of the English colony at Oporto. From Mattozinhos to the bar of the Douro there are several small sandy shores utilised for baths by the residents of Oporto; one of these is known as the «praia dos ingleses», or the beach of the English. The Spaniards form a very large percentage of the foreigners who frequent the sea-bathing resorts in Portugal.

The temperature of the water along the coast of the N. Atlantic region is warmer in summer and autumn than that of the water on the coast of the Lusitanian. This is due to the influence of the Gulf Stream, which in these seasons sweeps from north to south.

The sea-water, collected on the coast of the Povoa do Varzim, was roughly analysed about 90 years ago. A litre of water contains a solid residue of 31gm.04, as follows:

Chloride of sodium......................gm.	28.80
» » magnesium....................	4.86
» » calcium........................	0.78
Sulphate of sodium........................	3.60

The sea-baths are frequented mostly in late summer and early autumn. Owing to the milder climate, they

are, generally speaking, preferable to those in the south. The south-west winds which are felt in this region even in summer render the climate more saline.

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Note. Most of the medical officers in charge of spas publish memoirs and reports in connection with their stations.

CHAPTER XV.

HEALTH RESORTS IN THE LUSITANIAN REGION.

Climate: cool and feebly dry in winter; hot and very dry in summer.

Spas: muriated and sulphureted.

A. CLIMATIC RESORTS.

The principal resorts in the Lusitanian region are: Cintra, in the subregion Northern Estremadura; Mont' Estoril and Lisbon, in the Central Estremadura; Setubal, in the Southern Estremadura; and Guarda, in Beira Baixa. The subregion Central Estremadura may be styled the Land of Perpetual Spring or Perpetual Garden, for the roses and some of the mimosas flower there during the whole year.

With the exception of Guarda, all the other resorts are situated in the district of Lisbon. Among the capitals or chief towns of the districts not included among the health resorts are Leiria, Santarem, Castelo Branco, and Portalegre. Leiria, 113 m. above the level of the sea, is situated in a very fertile valley bathed by the Liz and the Lena, and is dominated by a hillock with picturesque ruins of an old castle,

formerly the residence of D. Deniz, named the Husbandman. Santarem, 100 m., placed upon a small hill, was for a certain period the seat of royalty; it commands an excellent view of the Tagus, especially in winter. Castelo Branco, 470 m., lies on a high and picturesque situation. And Portalegre, 480 m., is situated on a spur of the Serra of Portalegre.

1. CINTRA, AND THE SERRA OF CINTRA.

Cintra: *marine, sea-breeze-hill, very sylvan, most temperate. Winter: cold and moist, rainfall moderate. Summer: warm and feebly moist, rainfall very scanty.*

Cintra (from Cynthia, the moon: there was formerly at Cintra a temple dedicated to the Moon) is one of the most charming resorts not only of Portugal, but of the whole of Europe. It was well known to the Romans and to the Moors. The monks of St. Jerome had a monastery at Pena. The widespread renown of Cintra among the English-speaking people is due to the glowing descriptions of the place given chiefly by Beckford, «the wealthiest son of England», by Southey, and by Byron. «No words can convey», says Beckford, «an adequate idea of the bloom of the atmosphere of Cintra, and the silvery light of the sea» (1). Southey considers it the most blessed spot on the habitable globe,

> «Where the tired mind
> Might rest beyond the murmurs of mankind» (2).

And Byron compares it to a «glorious Eden, in a variegated maze of mountain and glen» (3).

The central portion of the town of Cintra, where the Paço de Cintra or the Old Palace is situated, lies in the north-eastern extremity of the Serra of Cintra in 38°, 47′2″ N. lat., at an elevation of 207 m., and at a distance of 9 km. from the sea, and of 28 km. by rail from Lisbon. Its highest point, the Cruz Alta, or the High Cross, attains an elevation of 529 m. The soil consists of secondary formation, with some granite and some modern. One of the great advantages of the place is that it is so near the sea.

The vegetation is extremely rich and varied. It is very rich in palms, mosses, and ferns. The tree-ferns thrive exceedingly well, and form a marked feature of many gardens. The camelias are abundant and superb. Various species of araucarias and eucalyptuses grow luxuriantly. Among the indigenous trees and shrubs the most worthy of note from the climatic point of view are the sycamore *(Acer pseudo-Platanus)*, the Lusitanian prune *(Prunus lusitanica)*, the Portuguese or the acute-leaved ash *(Fraxinus angustifolia)*, the bilberry *(Vaccinium Myrtillus)*, and the sweet-gale *(Myrica Faya)*.

The population is 7,380, and the number of households, 1760. Most of the villas are surrounded by beautiful gardens, and a few by large parks. On the summit stands the Palace of Pena, on the site of a monastery founded in 1503, and towards the western extremity of the town is Monserrate, the splendid property of the Cooks since 1863.

The climate of Cintra is very agreeable in summer. The mildness is due not so much to the elevation as to the vegetation, and to the mountain and sea breezes. The temperature at the central part is about 3° to 4°

degrees lower than in the surrounding country. The mountain intercepts the moisture of the north and the north-west winds. The evaporation from the dense vegetation increases the amount of moisture in the air. The climate, as a whole, has a great similarity with that of the North Atlantic region, as is evident from the presence of the sycamore and other trees.

The meteorological observatory, placed on the northern side of the town and in a hollow, does not give an accurate idea of the central portion where all the hotels are situated. The Observatory was opened in 1908, and is located at an elevation of 205 m., as compared with 95 m. at Lisbon. The mean temperature at 9 a.m. in the first and the last decades of January 1909, were 9°.7 and 8°.4, as compared with 7°.49 and 8°.4, respectively, at Lisbon. In July the figures were 19°.94 and 20°.7, as compared with 22°.47 and 22°.3. The means of the maxima and the minima, of the first and the last decades in January were 12°.97 and 6°.9; and in July 22°.84 and 15°.57. As the station is used as a summer resort, the figures for July are rather high. The real value of the place will be better established when the observatory is removed to the centre of the town, as it will be done very shortly. The relative humidity is more than that of Lisbon, and so also is the rainfall. In summer the top of the mountain is often covered with mist.

The air is very pure, soft and balmy. «It is a positive pleasure», says Southey, «to breathe the air of Cintra». And Beckford remarks: «This morning there was a mild radiance in the sunshine, and a balsamic serenity in the air which infused that voluptuous listlessness, that desire of remaining im-

paradised in one beautiful spot, which in classical fictions, was supposed to render those who had tasted the lotus, forgetful of country, of friends, of every tie».

The water supply is good and abundant. The roads, if not well-watered, are inclined to be dusty. The death rate is low.

Cintra is most useful in spring and in summer. Persons in good health can stay there throughout the year, but the invalid should avoid it in winter. Compared with Bussaco, it is more stimulant and perhaps more tonic. It is useful in anaemia, in some forms of neurasthenia, and in some bronchial affections. It should be avoided by the rheumatic and the gouty. Its historical monuments, its flora, and its scenery form great attractions to the tourist.

The Serra of Cintra runs from east to west, commencing at Cintra and ending in a bold headland of bare rock at the Cape Roca, known to the ancients as the *Promontorium Magnum*, and to the English sailors as the Rock of Lisbon. It is 10 km. in length, and at one portion, from Colares to the Quinta of Penha Longa, 7 in breadth. It is more imposing and picturesque on the northern side, on which it rises rather abruptly, than on the southern side, on which it slopes gradually towards the Bay of Cascaes. The full climatic resources of the serra, especially of its altitude and of its southern slopes, have not yet been utilised.

Besides the town of Cintra there are some other places of climatic interest in the serra. On the northern side, not far from Cintra, lies the Golden Valley of Portugal, with Colares, a beautiful, quiet, and reposeful

village, famous for its vineyards, its orchards, and its Convent. On the western side, not far from the Cape Roca, is situated Azoia, the westernmost village of Europe. On the southern side stands the Quinta of Penha Longa, a country house well worthy of a visit from the historical point of view. Formerly there was at this place a monastery belonging to the monks of St. Jerome, founded in 1355.

Cintra is susceptible of great improvements. A good hotel in the valley of Penha Longa or not far from it, fully exposed to the south and well sheltered from the north and the east winds, would be very useful, for it could be utilised both in winter and in summer. It should have a suitable elevation, so as to command a good view of the sea, and be exposed to sea-breezes.

One of the marine places in the subregion Northern Estremadura, suggested as very suitable for a sanitarium for consumptives, is S. Pedro de Muel (Ch. IX. 2), which has excellent pine woods close by.

2. MONT'ESTORIL, AND THE PORTUGUESE RIVIERA.

Mont'Estoril: *marine littoral-hill, most temperate, fluctuation very moderate, range equable. Winter: cool and feebly dry, mildly saline, rainfall very moderate. Summer: warm and dry, very feebly saline, rainfall very scanty.*

Mont'Estoril is the most equable, and one of the most temperate littoral stations on the whole of the Continent. Any reader interested in this subject will find full details in two of my papers published during the last few years (1).

Mont'Estoril is situated on the Portuguese Riviera, in 38°.41′35″ N. lat., or in the same latitude as Messina in Sicily; and at a distance of 19 km. by rail to the west of Lisbon. Its mean elevation is 40 m., and its highest altitude is 109. It forms a gentle declivity towards the coast. The soil is very permeable; it consists of sandstone and shale beds intercalated. The shore is sandy, being interspersed with beautiful rocks. The station owes its privileged condition to the influence of the Gulf Stream. The vegetation is luxuriant and varied. Lady Markham has published a list of plants which flower at Estoril in winter and in the early spring (2). There are fine pine woods all round, but chiefly towards the east and the west. The population is 970; and the number of households, 180. The hotels are situated at an elevation of 40 m.

Mont'Estoril, as a winter climatic resort, has come into use only since 1904. A temporary official post for meteorological observations was opened in February 1913.

The mean temperature of the place in *winter* is 11°.5, and the diurnal variation 5°.5, the former being 1° more and the latter 1° less than at Lisbon. The differences are due to the greater proximity of Mont'Estoril to the sea, to the direct influence of the Gulf Stream, to the reflexion of heat from the surface of the sea, especially in the early morning and the late afternoon, to the lower elevation, and to greater shelter. The difference in temperature between 9 and 15 o'clock is between 2° and 3° degrees; and the difference between sun and shade is between 21° and 22°. The medical day in the height of winter may be said to last 8 hours, from 8 to 16 o'clock.

The mean relative humidity is about 72. The climate is such that boots never become mouldy, the pavements are not moist in the morning, the tiles are not covered with moss, and iron never gets rusty. The amount of rainfall is 250^{mm}; and the number of days of rain of more than 1^{mm} in 24 hours is 35. It rains more frequently during the nights than during the days. Owing to the rapid absorption and the easy drainage, the roads dry up within a very short time. Mists are very rare; they occur only twice or thrice during the whole season. There is never any snow, and never any frost during the day.

The prevalent winds are the N., the N. N. E. and the N. N. W. The east winds are extremely rare. The force of winds is moderate; and there are a good many days of comparative calm. On the whole, Mont' Estoril is sheltered from the unfavourable winds in winter and exposed to favourable breezes in summer. The are no mistrals, and no siroccos.

The mean amount of sunshine in December is 4 ½ hours per day. The sunlight is particularly strong, due partly to the absence of mists and partly to the radiation from the surface of the sea, especially when the sun is low.

In *summer* the temperature is lower than in Lisbon, and the relative humidity is more. There is hardly any rain. The winds are strong; and the sea and land breezes are well developed.

The air is very pure, soft, marine and healthy, it is sweet and balmy, especially in spring and in summer The roads are dusty if not well watered.

The climate of Mont'Estoril, judged by its flora, consists of two springs and a summer. Some of the

flowers which flower only once during the year elsewhere, flower and yield fruit twice a year at Estoril, once, as usual, in the spring and summer, and once again in autumn and winter. The vital functions of such plants get only a very short repose. Mont'Estoril may be considered to be a regular natural hot-house of the Continent.

The water supply is obtained from two independent sources: one from the Vale de Cavalos on the slopes of the Serra of Cintra; and the other from the Quintas of Estrada and Caparata. The former, which supplies the western portion of the station, is very soft and very pure, the total solid residue being $0^{gm}1520$; and the latter, which supplies the remaining part of the station, is also pure, but somewhat calcareous, the total solids being $0^{gm}3824$. The drainage is very good. The mortality is extremely low.

Mont'Estoril is one of the few littoral stations frequented both in winter and in summer. It is at its best in winter, or in the English season, than in summer, or in the Portuguese season. It is extremely *useful* in winter to the old and the feeble; and it is beneficial in convalescence in most of the diseases. It is specially indicated in anaemia, in chlorosis and in scrofula. It is useful in rheumatism and in some forms of gout. It cannot be recommended in consumption, and it should be avoided by those subject to Bright's disease and to advanced heart disease. It forms an excellent intermediate station to those who come from the tropics, and specially to those who suffer from malarial diseases.

In March and April the sun is at times too strong for most of the people coming from the cold belt.

If precautions be not taken to wear a suitable hat or to carry a sunshade, they may get slight headaches or cold in the head and sore throat. These effects soon pass away with a little rest.

There are several good walks and interesting excursions to be made from Mont'Estoril. One of the greatest advantages of Mont'Estoril is its proximity to Lisbon. An invalid can at once obtain any special advice he may require, and the tourist has within an easy reach a place where he can amuse himself according to his tastes. Another advantage, at least for those who are not sea-sick and dislike long railway journeys, is that Lisbon is in direct, frequent and rapid communication with most of the principal seaports. The distance between Lisbon and Mont'Estoril by rail is only of half-an-hour. The greatest need of Mont' Estoril is a golf course.

In one of my papers a full comparison has been made between the climates of Mont'Estoril and Lisbon with those of Biarritz, Nice and Catania; and in another paper, between Mont'Estoril and Malaga. The mean temperature of Mont'Estoril in winter, 11°.5, as compared with the principal continental winter littoral resorts, is as follows: Abbazia 6°.7; Arcachon 8°.9, Biarritz 6°.8, Cannes 9°.8, Hyères 8°.5, Mentone 9°.5, Monaco 9°.9, Naples 9°.8, Nice 7°.8, San Remo 10°.5, and Venice 3°.3. And what is still more important is that none of these places has such a low diurnal range, and such an amount of sunshine as Mont'Estoril. The temperature of Malaga in midwinter is 12°, but the diurnal range is much higher, and there is a disagreeable land wind known as the *terral*.

The Portuguese or the Lusitanian Riviera is the

name given to a narrow belt of land bounded on the south by the coast and on the north by a range of hills, varying from 50 to 200 m. in height. Its total length is only 8 to 9 km. and its breadth from 0.5 to 3 km. It commences on the west at the Point of Salmodo, on which stands the lighthouse of Santa Martha, and ends at the Tower of St. Julian on the Point of Lagos. It takes first a rather sharp E. N. E. direction up to Mont'Estoril, and then a gentle E. S. E. course down to the mouth of the Tagus, thus forming, combined with the hills in the background, a great amphitheatre.

To the south of the Riviera spreads the beautiful Bay of Cascaes, 48 km. in length from Cape Roca to Cape Espichel, and 12 km. up to the estuary of the Tagus on the west. Towards the north, at a distance of about 8 km., rises the Serra of Cintra; and towards the south, beyond the Bay of Cascaes, runs the range of the Serra of Arrabida.

The shore of the Riviera is sandy, interspersed with beautiful rocks. Its slope is gentle, so that it is well adapted for sea-bathing.

The following are the principal stations along the coast of the Riviera: Cascaes to the west of Mont'Estoril; and St. Antonio do Estoril, S. João do Estoril, Cae Agua, Parede and Carcavelos to the east.

Cascaes is the chief town of the «concelho» or commune of Cascaes, and Mont'Estoril belongs to the parish of Cascaes. Its mean elevation is 30 to 40 m. It is bathed by the sea on all sides excepting the north. It is fully exposed towards the north-east, and is partially sheltered on the north and to some extent on the north-west. It has two public gardens, and a nicely

wooded private park. Its population is 2,530 and the number of households, 876.

This town is more exposed to the north-east winds than Mont'Estoril and is, therefore, somewhat cooler in winter, but on the whole the difference is not great; the water supply is very good, but only 8 to 9 l. per head.

Cascaes is largely frequented by the Portuguese in summer. It has a good Sporting Club. Some of its buildings, especially the Cidadela or the old Royal Castle, are of interest to the tourist.

St. Antonio do Estoril and S. João do Estoril are full of villas belonging to professional and commercial classes in Lisbon, all of which are occupied in summer. Cae Agua is a rising place. All these stations are in need of a good shelter on the north. Parede has a large population. It has a Sanitarium established by Madame Chamiço for some incurable diseases. Carcavelos is the head-quarter in Portugal of the Eastern Telegraph Company. It has a small English colony. It has also a Sanitarium for the treatment of tuberculous diseases of bones, scrofula and rickets.

According to Dr. Labat, the mean winter temperature in the Rivieras di Levante and di Ponente, or in those of Italy and of France is 8° to 10°.0; the oscillation between morning and evening is 4° to 6°; between day and night is very great; and between sun and shade 30° (3). In the Portuguese Riviera the mean temperature is higher by 2° to 3°; the oscillation between morning and evening is lower by 1° to 3°; there is less difference between day and night; and between sun and shade it is lower by 8° to 9°. All these differences are easily explained by two simple facts: the Portu-

guese Riviera is in the same latitude as Sicily; and it is fully under the influence of the Gulf Stream. In the Portuguese Riviera the mean number of the hours of sunshine in winter is much greater, and there is never any snow, never any frost during the day, and no mistral. The amount of rainfall in winter is about the same as in the French and the Italian Rivieras.

The Portuguese Riviera forms the line of junction of the polar and the equatorial climates on the western coast of Europe; it represents the mean temperature of the earth, and the point of junction of the polar and the equatorial floras.

3. LISBON, AND ITS ENVIRONS.

Lisbon: *urban, marine, riparian-saline-hills, most temperate, fluctuation very moderate. Winter: cool and feebly dry, equable, rainfall very moderate, evaporation very feeble. Summer: moderately hot and very dry, variable, rainfall very scanty, evaporation moderate.*

Lisbon, the capital of Portugal and in its beauty, in the words of Camoens, «easily the Princess» of all the other cities, has the mildest and the most equable climate not only of all the capitals, but also of almost all the health resorts, of Europe. The whole city is situated on the right bank of the Tagus, in 30° 42'31" N. lat.; its western limit, the Portas de Algés, being 6 km. from the sea. It occupies an area of $84^{sq.km.}452$, its greatest length from north to south being $10^{km}5$, and its breadth 10 km. It has a perimetre of $40^{km}5$, out of which $17^{km}500$ are on the borders of the Tagus. Its general direction is gently N.E. to S.W., so that it

may be said to face the S.W. The city has a tendency to increase towards the east rather than towards the west.

The main portion of the soil of Lisbon is tertiary, with basaltic and limestone protrusions; the eastern portion, beyond the Baixa, is entirely tertiary; the western portion, beyond the valley of Alcantara, is partly basaltic and partly cretaceous; and the central, contains of all the three soils.

Lisbon consists of what is known as the old or the smaller city, and of the new or the larger city; the highest elevation in the former is Campolide, 130 m., and in the latter Monsanto, 226 m. The old city consists, like Rome, of 7 hills: Castelo, Graça, Penha, Rio de Janeiro, Campolide, Buenos Aires, and Estrela: its mean elevation is 45 m. The lowest part of the town consists of the portion lying on the border of the Tagus; of the Baixa or the valley formed by Castelo and Graça on the east and by Rio de Janeiro on the west; and of the valleys of S. Bento and Alcantara.

The mean width of the Tagus from its mouth up to the Caes de Sodré (the Quay of Sodré) is about 2 km.; higher up, in front of the Black Horse Square, it widens to the extent of 12 km. This large expanse of water has a considerable influence upon the climate. The several quays built all along the bank of the river have improved very considerably the sanitary condition of the city. There are no marshes in its vicinity. The subsoil water in the Baixa and in the valley of Bemfica is high.

The old city has several public gardens and open spaces; and the new city contains several fields and uninhabited elevations. The newer portions of the

town are formed of broad avenues planted with trees. The most important public gardens are Edward VII. Park, Campo Grande, Zoological Garden, Botanical Garden, Rio de Janeiro, S. Pedro d'Alcantara, Alto de Santa Catharina, Estrela, Tapada das Necessidades, Tapada da Ajuda, and Garden of Algés. The vegetation and the general physiognomy of Lisbon impress themselves very characteristicaly upon those who visit the city for the first time. «The vegetation of Lisbon», says Leclercq, «is entirely meridional. I have seen plots of ficoids which replace there the grass plots of our gardens. The orange and the citron trees acquire there a greater development than in the southern provinces of Spain; they are laden with fruit in full winter. In deep winter also flower the camelias, at the shade of which grow large cactuses. This perpetual spring, the brilliant flora, the soft and limpid sky, which is not defaced by a single cloud, and the bright sunshine which makes the wide roadstead shine like a polished glass, give the charming Portuguese capital such a happy physiognomy as to make a foreigner to wish to fix his penates there» (1). Lisbon has had always, from the time of the Romans and the Moors, a great renown for the excellent quality of its fruits and flowers.

The population of Lisbon is 435,360, and the number of households 93,185, or there are 4.35 persons in each household. The old portion of the town, such as the Mouraria and other places at the foot of the Castle St. George, consists of very narrow streets, and is greatly overcrowded.

The *climate* of Lisbon is under the influence of the sea and of the Tagus which render it both mild in winter and not very hot in summer.

An old writer in his enthusiasm for the climate of Lisbon says:

> «*La clemencia de tu cielo*
> *Es tal, que no so aperciben*
> *En inverno, ni en verano*
> *Com que poder resistirse;*
> *Ni en verano hace calor*
> *Ni en inverno se permite*
> *Mudar habito, ni hacer*
> *Los fuegos a el convenibles*» (2).

«The mildness of the climate is such, that it is not easy to say when it is winter and when it is summer, for neither in summer is it hot, nor in winter is it necessary to wear warm clothes or to have fires». Amatus Lusitanus also holds a similar opinion.

The mean temperature in winter is 10°.78; in spring 14°.98; in summer 21°.01; and in autumn 16°.89. The mean of the maxima and of the minima in the four seasons are: 13°.76 and 5°.37; 18°.83 and 6°.98; 25°.73 and 8°.41; and 20°.50 and 6°.46. The highest temperature registered is 38°.8 and the lowest 0°.4. The diurnal range or oscillation, according to Prof. Almeida Lima, is 5° during the year, and 3°.9 in winter. The evaporation in winter is 89 mm., and in summer, 475. The relative humidity in the four seasons is 75.0, 63.6, 59.4 and 68.2. The rainfall in winter is $259^{mm}.9$, and in summer, 39.9. The mean number of days of rainfall is 113.6; and of mist 24.8. Snow and frost are meteorological curiosities. The greatest amount of rain corresponds with the S.S.W. winds. The total number of days of mist is 17.5, out of which 6.1 are in winter, and 1.1,0.6,5.6 in the three succeeding seasons. There are 15 days of thunder during the year, more in spring and in autumn

than in winter or in summer. The mean number of hours of sunshine in December is 131, and in winter 425.

The air of Lisbon varies in different parts of the town. It is not pure in the centre of the town, especially where there are some factories. It is very pure and healthy in the new avenues towards the eastern side of the Edward VII. Park, and on some portions of the hill of Belem.

The climate of Lisbon as regards its pressure, temperature and humidity has been studied in great detail by Brito Capello (3). Among recent studies may be mentioned the elaborate tables of temperature by Prof. Almeida Lima (4). An excellent chart showing the rainfall according to the four seasons from 1856 to 1910 by Prof. Almeida Figueiredo is worthy of note (5). In this section the figures of some of these papers have been quoted, and not those for 10 years as in the first part of this book.

The water supply is obtained from two distinct sources: from Riacho das Aguas Livres, which is good; and from the Alviela, which is very good, pure and wholesome. The aqueduct of the Aguas Livres is an astonishing piece of work, carried out in the xviii. century with a useless amount of enormous expenditure for the want of the knowledge of the simple fact that water finds out its level. The supply is 100 litres per head.

The mortality is 23.2 per mille. The most common diseases are catarrhs of bronchial tubes and rheumatism, in winter; simple colds in spring; and intestinal complaints in summer and in autumn.

Lisbon was greatly in favour of the British physicians as a health resort for about 80 years, from 1750 to 1820. They considered it very useful in consumption

and other diseases. Dr. Mead, writing in 1757, says: «Ex nostra regione, male affecto pulmone amplissime Olyssiponem... itur» (6). After 1820, owing partly to political convulsions, and partly to the want of more rapid communications and some other causes, it fell into disuse.

The climate of Lisbon is at its best in spring. The best localities for an invalid are the slopes of hills facing the south, such as those of Belem and of Buenos Aires. Lumiar has a reputation as a beneficial place for the consumptives; and some portions of Bemfica to those suffering from nervous complaints. On the whole, a large city is not so favourable to an invalid as a country place. Of the medical institutions those of interest to an English invalid are the British Hospital at Estrela in charge of a British physician; and the Institute of Dr. Vergilio Machado to those who require electrical treatment.

Lisbon affords numerous objects of interest to the tourist and the pleasure seeker. It is the best centre for several most interesting excursions.

The following table shows at a glance the means of the temperature of Lisbon as compared with those of London, Paris, Madrid, and Rome:

	An.	Wt.	Spr.	Sm.	Aut.	Days of Rain.
London	9°.1	3°.1	8°.0	15°.5	9°.6	178
Paris	10°.8	3°.3	10°.4	18°.1	11°.2	134
Madrid	13°.4	4°.9	11° 9	23°.0	10°.1	126
Rome	15°.8	7°.5	13°.8	24°.9	18°.3	113
Lisbon	15°.6	10°.6	14°.3	20°.6	16°.6	117

Lisbon compares very favourably with several well known health resorts.

Few cities possess such beautiful and healthy environs and suburbs as Lisbon. Cintra and Mont'Estoril have already been described, and Setubal will be described in the next section. Along the right bank of the Tagus or along the Lisbon-Cascaes railway line there are several places used by the Lisbon people both for a change of air and for sea-bathing. The most important of these are Dafundo, Cruz Quebrada, Caxias, Paço d'Arcos, Santo Amaro, and Oeiras. On the left bank of the river, from east to west, are Barreiros, Cacilhas, Almada, which commands a beautiful panorama of the City of Lisbon, Trafaria, a favourite place for sea-bathing, and the Lazareto.

Some places to the north of Lisbon have enjoyed a reputation in the treatment of lung diseases. Dr. Fothergill recommended in 1784 «the vicinage of Lisbon and of Cintra» in the treatment of consumption (7), and it is interesting to note that Queluz-Belas, a pleasant locality on the Lisboa-Cintra railway line, is in request in summer, even now-a-days, in pulmonary diseases. Some medical men consider Cabeço de Montachique, an elevation of 408 m., and at a distance of 23 km. to the north of Lisbon, to be one of the best health spots in the neighbourhood of Lisbon.

4. SETUBAL, AND THE SERRA OF ARRÁBIDA.

Setubal: *marine, riparian-saline-lowland. Winter: cool and dry. Summer: moderately hot and very dry.*

Setubal, or the St. Ubes of the old foreign writers, lies in 38°, 31′ 2″ N. lat., on the southern side of the

range of the Serra of Arrábida and on the eastern shore of the Estuary of Setubal, in a low plain with a mean altitude of 8 m. It is situated at a distance of 38 km. to the south-east of Lisbon, and connected with it by a railroad and a steam ferry. The soil is tertiary with some modern. There are no marshes in its immediate neighbourhood.

The Port of Setubal, 15 km. in length from north to south, and 3 to 4 in its greatest breadth, is one of the most sheltered sheets of water in western Europe. The harbour is not so large nor so long as that of Lisbon, but it is much more safe. It is sheltered from the ocean by a natural and complete breakwater formed by old Troia. The border of the city on the Estuary consists of an embankment of solid masonry. Setubal is full of orchards; it has some of the best orangeries in Portugal. The population is 30,350, and the number of households, 6,255.

The climate of Setubal is more Mediterranean than Lusitanian. The temperatures, both in winter and summer, are higher than those in Lisbon; the relative humidity and the amount of rainfall are less. The prevalent winds are the N.N.W and N.E. There is unfortunately a small gap in the serra on the northern side, which exposes the city to the north winds when they are strong. The water supply is obtained from public and private wells, and it is rather hard. The public health is good in winter. There are no intermittent fevers within 20 km. of the town.

The environs of Setubal have always had a great reputation in the treatment of lung diseases. Setubal affords exceptional advantages to those who are fond of boating and fishing.

The SERRA OF ARRÁBIDA forms one of the most important climatic assets of Portugal. Just as the northern side of the Serra of Cintra, owing to its elevation and exposure to the N. and the N. W. winds, brings within an easy distance of Lisbon the North Atlantic climate in summer, so some of the portions of the Southern side of Serra of Arrábida, owing to the shelter from the N. N. E. and the N. W. winds, and to its greater proximity to the sea, bring also within an easy distance from Lisbon the Mediterranean climate.

The Serra of Arrábida is 25 km. in length; it runs from east to west and ends at the Cape Espichel, the *Promontorium Barbaricum* of the ancients. Its highest peak, Formosinhos, rises to 499 m.; its soil is calcareous. Its pecularity as compared with the Serra of Cintra is that on the southern side, from Setubal to Cape Espichel, it borders first on the Estuary and then on the Bay; whereas Cintra touches the sea only at its western point: the consequence is, Arrábida is more under the influence of the sea. The sea and the mountain breezes are more developed.

The Mediterranean nature of the climate of the Serra of Arrábida is well attested by the presence of the dwarf palm (*Chamaerops humilis*), the purple phlomes (*Phlomis purpurea*), and the carob (*Ceratonia siliqua*), which attain there their northernmost or their polar limit. The serra is a land *par excellence* of lavender and rosemary, which grow everywhere.

The climate of Arrábida has enormous capabilities. It is a perfect mine of wealth to anybody who will explore it intelligently. The friars, as usual, knew perfectly well the advantages of the place, and had a

monastery in one of the most sheltered spots. The great advantages of Arrábida are: its proximity to Lisbon, and the perfect safety of the Estuary and the Bay for boating and fishing. Owing to the strong sea-breezes, the climate is agreeable also in summer.

Among the places worthy of notice in the Serra are: Palmela, Outão, and Monte Regina on the southern side; and Azeitão and Vila Fresca de Azeitão on the northern.

Palmela, a charming hill, 238 m. in elevation, is situated to the north-east of Setubal and at a distance of 6 km. It was formerly the seat of the military order of St. James. It is one of the healthiest spots of the Serra. Zacutus Lusitanus recommended it long ago as a good place for the treatment of consumption (1).

Outão, to the west of Setubal, has a Sanitarium for the treatment of scrofula, tuberculosis of the bones and rickets, in a building known as the Tower of Outão, which was a long time ago one of the royal residences. In the Roman period, there was at this place a temple dedicated to Neptune. The climate of Outão is considered to be extremely healthy. According to Dr. Lencastre, the temperature in winter is between 13° and 15°; and the mists are very rare, during 13 years the mean was 15 hours and 36 minutes in August, and 1 hour 42 minutes in May; the monthly mean being 12 hours (2).

Monte Regina is a small plateau with a mean elevation of 125 m. above the Portinho of Arrábida. It is one of the most sheltered spots of the Serra: a regular hot-house in winter. Higher up, at an elevation of 289 m. stands the old monastery of Arrábida; and

still higher up rises the Formosinhos, on which, it is said, the Romans had a temple dedicated to Apollo. Monte Regina is considered to be, by competent observers, the best seaside place in winter for the treatment of lung diseases, and for all the feeblest convalescents. The great need of the place is a good sanitarium.

Azeitão and Vila Fresca de Azeitão have, in summer, a much cooler climate than Lisbon. They were formerly very fashionable resorts.

5. GUARDA, AND THE SERRA OF ESTRELA.

Guarda: *marine, inland-mountain, cool temperate, fluctuation high. Winter: very cold and moist, equable, rainfall and evaporation moderate. Summer: moderately warm and very dry, moderately equable, rainfall scanty, evaporation excessive.*

Guarda or «The Guard», so named because it guards the entrance to the valley of the Zezere, was founded by Sancho I. in 1199. It is situated on the top of a mountain in the northern portion of the Serra of Estrela, in 40° 33′ N. lat., at an elevation of 1.039 m., and at a distance of 120 km. from the sea coast, and of 30 km. to the north of the highest peak of the Estrela. The vegetation is very sparse. The number of inhabitants is 6,635, and of households, 1,530.

The mean temperature in winter is 4°.25; in spring 9°.22; in summer 18°.57; and in autumn 11°.22. The means of the maxima and the minima in the four seasons are: 6°.96 and 1°.34; 13°.18 and 5.15; 23°.5 and 13°.35; and 14°.52 and 7°.19. The evaporation in winter is 178^{mm}, and in summer 726; and the mean relative

humidity is 80.3 and 49.7, respectively, in the two seasons. The rainfall is $338^{mm}.2$ in winter, and 75.9 in summer, and the mean number of days of rain during the year, 103.8. The mists are frequent, they occur more in winter and autumn than in spring and summer. The place has no good shelter; the prevalent winds in winter are from the S., and in summer from the N.W. The daily variations of temperature are more similar to those of Lisbon than of Oporto; and the mean annual temperature, and the mean monthly and seasonal temperatures are similar to those of Paris. The water supply is scanty, 14 l. per head. The city and its environs would be greatly improved by the plantation of some more trees.

Guarda has been selected as a station of moderate altitude by the Society of National Help to the Tuberculous as their principal district station for the treatment of consumptives. It is there that it has its best Sanitarium. Guarda is considered to be also useful in neurasthenia.

Of all the mountains, the Serra of Estrela presents the best high altitudes for the establishment of hotels and sanitariums. It has a central position, so that it is accessible to the residents both of Lisbon and of Oporto. Its direction is from north-east to south-west; its eastern side contributes to the formation of the valley of the Zezere, and its western side to that of the valley of the Mondego. Its highest peak, Cantaro Delgado, rises to an elevation of 1991 m.

The climate of the Serra of Estrela has attracted a good deal of attention. Prof. Serras e Silva, of Coimbra, has devoted to it one of his memoirs (1). The meteorological station known as the Estrela Ob-

servatory is situated at Poio Negro, a plateau without any good shelter, in 40°25′ N. lat., at an altitude of 1.386 m., and at a distance of 102 km. from the sea. The mean temperature in winter is 2°.25, in spring 7°.02, in summer 16°.88, and in autumn 9°.45. The means of the maxima and the minima in the four seasons are: 4°.86 and −1°.40; 10°.40 and 4°.31; 20°43 and 12°.72; and 12°.32 and 6°.61. The relative humidity in winter is 84.5, and in summer, 49.2. The total rainfall amounts to 2773^{mm}, the maximum being in winter. The number of days of mist is 125, and of snowfall, 36; both being more frequent in winter. The prevalent winds are W.N.W. and E.S.E.; and the mean velocity is 19.66.

Not far from the Observatory there are two unpretentious hotels and six or seven villas.

All competent observers are agreed that the Serra of Estrela is very useful in consumption. Some patients, who did not find any relief at Davos, have improved considerably and even been cured at Estrela.

The other places worthy of notice in the Serra are: Manteigas, Estrela-Covilhã, Unhaes da Serra, Vale do Conde, and Vale das Eguas.

Manteigas, situated towards the east of the Observatory, lies on the borderland of the North Atlantic and the Lusitanian regions, at an altitude of 775 m. It is reached from the railway stations of Gouveia or of Nelas; it is also accessible from Covilhã. Its population is 1.500. It is frequented by some people both for its climate and for its hot sulphurous mineral waters (§ 9).

Estrela-Covilhã has at present one of the best sanitarium in the Serra of Estrela. The Sanitarium Estrela-Covilha is situated at a distance of 8 km. from Covilhã,

and an altitude of 1530 m. It is the highest placed sanitarium in Portugal for the treatment of consumptives. Its aspect is southern; the mists are said to be rare; and the water supply is pure. It is open only in the fair season.

Unhaes da Serra is situated at a distance of 23 km. to the south-west of Covilhã, and at an altitude of 657 m. Its climate is described as mild, healthy and agreeable. It has a warm thermal spring of sulphur, useful in skin diseases (§ 9).

Vale do Conde, situated to the south-west of the Observatory, is considered to be one of the places suitable for the establishment of a sanitarium for consumptives. Its mean altitude is 1650 m. Its mean temperature in winter, according to Dr. Carvalho, is 1°.88, and in summer 12°.1; the means of maxima and minima in the former being 7°.66 and -6°.69: and in the latter 19°.61 and 4°.56 (2). Dr. Souza Martins, one of the most accomplished physicians of the last century, is of opinion that the climate of Vale do Conde is superior to that of Davos: «the variations of temperature are much more regular and more moderate; the daily variations being 3°.3 at Estrela and 8°.2 at Davos» (3). He recommends strongly the establishment of a sanitarium there for the treatment of consumptives. Compared with the Observatory at Poio Negro, it is much more sheltered, the winds are 47 % less, and the mists are also 50 % less.

Vale das Eguas, situated to the south of the Observatory at Poio Negro, has also been considered to be one of the suitable places for a sanitarium. In fact a beginning was made, some years ago, to build a hospital there.

One of the urgent needs of Portugal is a good hotel at an altitude of 1,400 to 1,600 m. for non-consumptives, for at present all those who require the climate of altitude have to go either to the Pyrenees or the Alps. Such a hotel would be specially useful to the inhabitants of Lisbon and Oporto, for both these cities are near the sea, and a change to a sea-shore or to a place near the coast is no real change. Moreover, a good hotel of altitude, if it had good golf links, would attract some foreigners in summer, and retain some of those who come to the country in winter.

C. SPAS.

The principal spas in the Lusitanian region are: Caldas da Rainha and Cucos, in the subregion Northern Estremadura; and Estoril and San Paulo (Lisbon), in the Central or Olysiponian Estremadura. With the exception of Caldas da Rainha, all the other spas are in the district of Lisbon. Among other sources may be mentioned the following: Charniche and Montachique, in the district of Lisbon; Manteigas, in Guarda; and Unhaes da Serra, in Castelo Branco.

6. CALDAS DA RAINHA.

Muriated, hot, moderately mineral, calcic sulphated, and sulphureted.

Caldas da Rainha or the «Thermal Baths of the Queen», so named after D. Leonor, wife of John II. are situated in the district of Leiria, 109 km. by rail to the north of Lisbon, in a wide and pleasant valley,

at an elevation of 40 m. above the sea level, and at a distance of 10 km. from the sea coast. The soil is tertiary, and the vegetation is abundant. The climate is agreeably warm in summer, the mean temperature being about 20°; the air is moderatly dry. The population is 2,569, and the number of households, 964. The drinking water is good, 45 l. per head.

This spa belongs to the State. It is supposed that it was known to the Romans. Its fame is due, however, to Queen Leonor, who, in recognition of the benefits derived from these waters, founded there a hospital in 1490, selling for this purpose, it is said, even her private jewels to King Manoel. There are several sources, all near each other. The waters are abundant; clear and transparent at the source, with a decided smell and taste of sulphur; their temperature is 34°.5. The first scientific analysis of these waters was made in 1795, by an Englishman, Dr. Withering (1). They have been analysed since then several times. The latest analysis gives the following results:

Chloride of sodium.................. gm	0.72048
» » magnesium.................	0.17952
» » ammonium................	0.00285
Sulphate of calcium..................	0.73877
» » sodium..................	0.25046
» » potassium................	0.04023
Bicarbonate of calcium................	0.28234
» » magnesium...............	0 09007
» » iron..................	0.00269
Phosphate of aluminium................	0.00338
Silica..................................	0.01973
Total solid residue.........	3.33052

Free carbonic acid..	0.14050
Sulphureted hydrogen	0.00998
Nitrogen	0.02488
Total	3.50588

These waters contain a larger percentage of phosphate of aluminium than all the other Portuguese waters. The thermal establishment is old but good.

The spa is extremely useful in rheumatism, syphilis, and uterine complaints. The waters are used both internally and externally. They are frequented more than any other spa. There are two seasons: one from 15th May to 31th October; and the other in January and February.

7. CUCOS.

Muriated, hot, moderately mineral, lithiated.

This spa is situated at a distance of 70 km. to the north of Lisbon, and 2 km. from the station of Torres Vedras, in a valley facing the north, at an altitude of 33 m. above the sea level, and at a distance of 13 km. from the sea. The climate is hot, dry, and healthy, the mean temperature in summer being about 25°. It is said that these waters were likewise known to the Romans, but their fame dates from 1892, from the building of the new establishment. There are three principal sources. The waters have a yellowish tinge, very saltish, and slightly bitter and styptic; the temperature of the three sources varies from 32°.21 to 37°.5. The total solids of the source Cucos Velhos are 3gm.3482, composed chiefly of chlorides of sodium, 2gm.538, and of lithium; and of bicarbonate of lime.

These springs throw out a large amount of vegetable and sandy mud, which is very radioactive.

This spa has a well deserved reputation in rheumatism and scrofula. The waters are used both internally and externally. There are good arrangements for mud-baths. The season lasts from 15th May to 30th September. The environs are pleasant, full of historical interest.

8. ESTORIL, AND POÇAS.

Estoril *is muriated, warm, moderately mineral, and calcic carbonated.*

Estoril (from *astur,* the falcon, and *il,* a place: a place frequented by falcons) was probably known or inhabited in the time of the Romans. The Franciscans founded a monastery there in 1527. It is situated at a distance of 18 km. by rail from Lisbon and at about 200 m. from the sea-shore. It is the most westerly spa on the continent. The climate is similar to that of Mont'Estoril; it is somewhat cooler owing to the dense vegetation of the park in which the Baths are situated.

The source of Estoril has been known for nearly 200 years, but its rapid development dates from the opening of the Lisbon-Cascaes railway line in 1889. Its temperature is 28°; sp. gr. 1.0013; and the total solid residue in 1000gm of water 4gm36, composed of the following ingredients:

Chloride of sodium.......................gm.	2.2624
» » potassium	0.0745
» » lithium	0 0042
» » ammonium	0.0011
» » calcium........	0.3846

Sulphate of calcium	0.0618
» » magnesium	0.3110
Bromide of magnesium	0.0041
Bicarbonate of magnesium	0.0523
» » calcium	0.3130
» » strontium	0.0041
» » manganese	0.0006
Phosphate of aluminium and bicarbonate of iron	0.0003
Silica	0.0274
Organic matter	0.0071
Iodides	small quantities.
Borates, nitrates, and bicarbonates of barium	traces
Carbonic acid (15cc.8)	0.0276

These waters are used both internally and externally, and are very beneficial in rheumatism, gout, and some skin diseases. So far as it can be judged, it cannot be said that they are superior or inferior to similar waters in Portugal or elsewhere. Their greatest advantage consists in the fact that they are situated in such an admirably equable and mild climate, that they can be utilised in winter. There are two establishments, one new and the other old. The ordinary season lasts from 1st May to 15th November, but one of the establishments is open in winter. It would be very advantageous to a good many invalids if there were a residential balneological hotel. Such a hotel could also have ordinary hydropathic treatment, electrical treatment in various shapes, and warm salt water baths.

Poças, a source similar to that of Estoril, both in composition and uses, is situated in the valley of Cadaveira, about half a kilometre to the east of the baths of Estoril. It could be likewise utilised, in winter, in the same way as Estoril.

Both the sources of Estoril and of Poças have been

described at length in one of my papers (1), in which the reader will find many other interesting details.

9. SAN PAULO (LISBON).

Sulphurous, tepid, very mineral, sodic muriated, gaseous sulphureted, and iodated.

The Baths of San Paulo or St. Paul are situated in the city of Lisbon, not far from the Square and the Church of St. Paul. They are also known as Dr. Lourenço's Baths, their original founder, and as Arsenal Baths, from the origin of the source. They lie at a distance of about 200 m. from the margin of the Tagus, being well sheltered from the northerly winds.

The Romans were well acquainted with these waters. An inscription found in 1770 shows that there was, even at the time of the Emperor Constantine, an establishment known as *Thermæ Cassianæ,* dedicated to Aesculapius. Their present renown is due to Dr. Lourenço, who, in 1868, built his original balnearium. The source of these waters is in the Arsenal of Marine, from which they are conveyed to the establishment by means of pipes. The water gets yellowish on exposure, it is saline and bitter in taste, and has a strong smell of sulphureted hydrogen; its temperature is 22°.5.

Its composition, according to Dr. Lourenço (1), is as follows:

Chloride of sodium .... gm.	17.1409
» » magnesium	2.3886
Bromide of magnesium	0.0198
Iodide of magnesium	0.0031
» » calcium	0.8254
Sulphate of sodium	0.6738

Sulfate of magnesium			0.7024
»	»	calcium	0.0053
»	»	strontium	0.0034
»	»	barium	0.0005
Phosphate of aluminium			0.0013
Phosphate of iron			0.0752
Sulphureted hydrogen			0.0762
Sulphide of ammonium			0.0113
Carbonate of magnesium			0.0909
»	»	calcium	0.4054
»	»	manganese	0.0007
Lithia			traces.
Acid carbonic			1.1154
Sulphurous acid			traces.
Siliceous acid			0.0134

The establishment has been recently rebuilt, and has all the necessary appliances. These baths have a disadvantage; the waters are liable to get mixed with the water of the Tagus when the tide is very high. The establishment receives a supply from the Poço de Albegoaria, the water of which is similar in composition to that of the Arsenal.

These waters are especially useful in rheumatism and syphilis, and all the complaints depending upon them. They are likewise useful in scrofula, neuralgia, and some diseases of the skin. They are used both internally and externally. The establishment is open throughout the year. There is no sulphurous spa in the whole continent which is situated in such a mild climate in winter as that of San Paulo. The usefulness of these waters could be greatly enhanced by building a hotel in connection with the baths, so as to convert them into a residential hydropathic establishment. Another way of rendering these waters useful in winter would be to convey them to one of the nearest hotels.

Charnice, a Quinta at Torres Vedras, has a source containing sulphate of magnesium, the total solids being $2^{gm}85$. It is worthy of notice as being the best specimen of the Portuguese bitter or purgative waters.

Montachique has a chalybeate source containing carbonate of iron in a considerable quantity (2). It was formerly in some vogue, but has now fallen greatly into disuse. As the place has a good elevation and an excellent climate (§ 3), it would be of great benefit to the anaemic to explore this source again.

Manteigas has two sources of hot, indifferent, sodic carbonated and sulphureted waters, useful in rheumatism.

Unhaes da Serra is tepid, indifferent, and sulphureted. It is useful in diseases of the skin.

The sources at Manteigas and Unhaes da Serra deserve special attention on account of the climate of these places (§ 5). Both the stations could be largely utilised both as climatic resorts and as spas.

C. SEA-BATHING RESORTS.

10. SEA-BATHING RESORTS IN THE LUSITANIAN REGION.

In the subregion Northern Estremadura, Nazareth is popular among certain classes; Ericeira, about 10 km. from Mafra has a well sheltered and pretty little bay; San Martinho do Porto has, besides a good shore, a comparatively mild climate; and Praia de Maçãs is connected by an electric tramway with Cintra.

In the Central Estremadura, Mont'Estoril and Cascaes are the most fashionable sea-bathing resorts of Portugal.

All the places along the Riviera and along the margin of the Tagus to the west of Lisbon, wherever there is a sandy shore, are utilised for sea-bathing. On the other side of the river Trafaria is a great favourite among children.

In the Southern Estremadura, Setubal and Cezimbra are utilised by some people.

The sea-water on the shore of Mont'Estoril has a temperature of 17° in December. Its composition according to an analysis, obligingly made for me by Dr. Vergilio Machado, is as follows:

Sp. gr. at 15° C.	1.028
Dry residue at 18° gm.	38.170
Chloride of sodium	26.459
» » potassium	2.483
» » magnesium	2.770
» » calcium	0.644
Sulphate of calcium	5.100
Silica, oxide of iron and of aluminium	0.015
Undetermined substances	0.600

The water of the Tagus, especially on the right bank, is not so pure as that of the Bay of Cascaes.

At Estoril, Lisbon, and Setubal there are establishments which provide warm sea-baths in summer and in early autumn.

The sea-baths at Estoril may be taken in winter by the inhabitants of the cold belt, for in this season the water is as warm as that of the Northern Sea in summer.

It would be advantageous if one of the hotels at Mont'Estoril and another in Lisbon would provide warm sea-baths in winter.

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CHAPTER XVI.

HEALTH RESORTS IN THE MEDITERRANEAN REGION.

Climate: cool and feebly dry in winter; hot and very dry in summer.

Spas: muriated and bicarbonated.

A. CLIMATIC RESORTS.

The most important climatic resorts in this region are Lagos, Faro, and Portimão. Algarve is styled the «Winter Garden of Portugal», and is sung in a popular ballad as

Terra de amores e de bosques,
Terra de amores e de flores.

Or «the land of love and of woods; the land of love and of flowers».

I. LAGOS, FARO, AND PORTIMÃO.

Lagos: *marine, littoral-saline-lowland, moderately warm, fluctuation moderate, regular land and sea breezes. Winter: modrately cool and feebly dry,*

equable, rainfall very moderate. Summer: moderately hot and very dry, moderately equable, rainfall extremely scanty.

Lagos, a city founded by the Carthagenians, is situated on the coast of a splendid bay, in 37°.6′ N. lat., and at a mean elevation of 15 m. It is sheltered on the north by the Espinhaço do Cão, or the Spine of the Dog, a prolongation of the Serra of Monchique, which ends at Cape St. Vincent, or the *Promontorium Sacrum* of the ancients. The vegetation is abundant. The mean temperature of Lagos in winter is 12°.38; in spring 16°.20; in summer 22°.09; and in autumn 18°.19. The means of the maxima and of minima in the four seasons are: 16°.89 and 8°.36; 21°.15 and 11°.21; 28°.18 and 16°.46; and 23°.45 and 12°.84. The relative humidity in winter is 75.0; and in summer 59.4. Rainfall $181^{mm}_{.}0$, and 20.2, in the two seasons. The mean number of days of rain is 57.4, and of mist, 0.2. There is never any snow and never any frost. The prevalent winds are N. and N.W., and S.E. and E. The water supply is pure, but somewhat hard. The population numbers 9,675, and the number of households is 2,400.

Faro, the capital of Algarve, is relatively milder than Lagos in winter; in January and February its temperature is somewhat higher, but in December it is lower. The relative humidity is lower in winter and higher in summer, and the rainfall is less. The soil is sandy. The characteristic feature of the vegetation is the well developed date palm. The population is 12,680, and the number of households, 2,970. At low tide a very large extent of the shore gets exposed.

Portimão is situated on the borders of the river of Portimão, and at a distance of 65 km. from Faro. Its climate is similar to that of Lagos. The inhabitants number 9,340, and the households, 2,350.

Vila Nova de St. Antonio is very pleasantly situated on the right border of the Guadiana.

The vegetation of Algarve is completely meridional. The carob, the date palm, the fig, and the dwarf palm grow there exceedingly well. The esparto grass *(Macrochloa tenacissima)* attains there its polar limit.

The medical uses of the different places on the coast of Algarve have not been specialised. All of them are useful in anaemia, in debility, in lung diseases, especially in asthma, and in convalescence after fevers. The most favourable seasons are winter and spring.

Compared with the Portuguese Riviera, the climate on the coast of Algarve is, in winter, warmer by about 1°, but it is less equable, and somewhat more moist. Compared with Madeira, it is cooler by 3° and much less equable. On the whole; it is more stimulant than that of Mont'Estoril and Funchal. There are no snow-covered mountains in its proximity, as at many of the places on the coast of Andalusia.

B. SPAS.

The only important spa in this region is Caldas de Monchique.

2. CALDAS DE MONCHIQUE.

Indifferent, warm, sodic muriated, and calcic carbonated.

The Caldas of Monchique is situated at a distance of 18 km. to the north of Portimão, and at an elevation of 250 m. in a well-wooded valley, sheltered on the northern side by the Serra of Foia, 902 m. The soil is schistic, and the vegetation consists chiefly of pines. According to Dr. Castel Branco, the mean temperature in summer is 23°, and in winter 12°, the relative humidity being 50 and 78, respectively (1).

The Romans were acquainted with these baths. There are four principal sources: their water is clear, without any particular taste or smell. The temperature of the source St. John is 32°.5, and its total solid residue, in 1,000 gm., is $0^{gm}283$, composed chiefly of chloride of sodium, and of carbonates of lime and magnesia. The bathing establishment is old; there is attached to it a hospital for the poor. The baths belong to the State, but are leased.

The waters are indicated especially in rheumatism, dyspepsia, and some skin diseases. They are used both internally and externally; their dose is 200 gm. The season lasts from 1st June to 30th September. These waters could be utilised in winter. There is an excellent park; and the country all round is very interesting. The town of Monchique, very pleasantly situated at an elevation of 450 m., is 6 km. from the Baths of Monchique.

C. SEA-BATHING RESORTS.

3. SEA-BATHING RESORTS IN THE MEDITERRANEAN REGION.

Almost all the places along the coast of Algarve are used as sea-bathing resorts by many of the inha-

bitants of the south of Portugal and by some Spaniards. The most favourite places are Praia da Rocha (Portimão), Praia da Luz (Lagos), and Albufeira.

The mean temperature of the sea-water is 21° in August, and 14° in February. The temperature is somewhat cooler than that at Estoril, a fact due to the influence of the Gulf Stream not being so direct.

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CHAPTER XVII.

HEALTH RESORTS IN THE NORTH CONTINENTAL OR THE ULTRAMONTANE REGION.

Climate: cold and moist in winter; hot and very dry in summer.

Spas: sodic bicarbonated.

A. & *B.* CLIMATIC RESORTS AND SPAS.

There are no climatic resorts in the North Continental region. This region may be styled the «Land of Mineral Springs», for there are in it some valleys which yield mineral waters almost everywhere.

Vila Rial, 420 m., the chief town of the district of Vila Rial, is situated upon a picturesque promontory formed by the rivers Cabril and Corgo in a deep and narrow valley. Bragança, the chief town of Bragança, lies on a plateau, 650 m. high, on the margin of the small river Fervença.

This region has two very impportant spas: Vidago and Pedras Salgadas. Among other sources worthy of note are Campilho, Aguas Romanas, Agua da Fonte Salus, Chaves, and Modelo, all in the district of Vila Rial; and Bem Saude in Bragança.

I. VIDAGO.

Alkaline, tepid and cold, very and moderately mineral, sodic carbonated, and gaseous carbonated.

Vidago, or the Life-giving Spa, is 183 km. by rail from Oporto. It is situated in the fertile valley of the Oura, at an altitude of 350 m., and at the foot of the northern side of the Serra of Vidago. The soil is granitic and dry, and the vegetation on the serra near the spa is abundant. The climate in summer is very hot and very dry.

There are two important sources at Vidago: Vidago no. 1, and Vidago no. 2.

Vidago no. 1, or the chief source, is one of the most important spas of its class not only in Portugal but in the whole of Europe. It was known to the Romans, who had there, during the reign of Trajan, a thermal establishment known as Vitaago (*vita* life, *ago* I produce). It had fallen completely into oblivion until 1863, when it was rediscovered by D. Julia Vaz d'Araujo. The water of Vidago no. 1 is clear, transparent, inodorous, and pleasantly prickly to taste. Its temperature is 23°.5, and its composition is as follows:

Bicarbonate of sodium	gm. 4.6290
» » potassium	» 0.0483
» » lithium	» 0.0373
» » strontium	» 0.0009
» » calcium	» 0.9713
» » magnesium	» 0.2554
» » protoxide of iron	» 0.0131
» » manganesium	» 0.0019
Sulphate of potassium	» 0.0089
» » barium	» 0.0010

Chloride of potassium	gm. 0.1695
Phosphate of aluminium	» 0.0007
Acid silicic	» 0.0611
Total...........	» 6.1980
Free carbonic acid.....................	» 1.4494
Grand total...........	» 7.6474

It also contains a considerable amount of radioactive substances.

Dr. Lourenço has framed a table showing the superiority of Vidago, as regards its chemical composition, as compared with 13 other principal spas of Europe (1).

Vidago no. 2 has a temperature of 17°.6, and a total solid residue of 4gm.1, consisting of bicarbonate of soda 3.3, and free carbonic acid 1.5. The sources of Vila Verde and Oura are less mineral, but contain about the same amount of free carbonic acid.

Vidago is extremely beneficial in dyspesia and in some forms of gout. It is recommended in congestion of the liver and of other abdominal organs, in skin diseases dependent upon stomach and liver, in diabetes, and in bronchial, vesical, and intestinal catarrhs. The season lasts from 1st June to 30th September. The water is bottled and is largely used and often abused, for it is taken by some people as a table water, which is a great mistake. Dose 50 to 100 gm. or more according to medical advice.

2. PEDRAS SALGADAS.

Alkaline, tepid and cold, moderately mineral, sodic bicarbonated and gaseous carbonated.

This Spa is situated at a distance of 168 km. by rail from Oporto, in a well-wooded valley, on the borders of the rivulet Avelames, and at an elevation of 580 m., being dominated on the eastern side by a serra rising to 1,150 m. It is one of the most beautiful watering places. Its soil is dry, the climate is cooler than that of Vidago, moderately hot and dry.

These waters have come into prominence since 1876. The principal sources are three. Their composition is similar to those of Vidago. Their temperature varies from 19° to 12°. D. Fernando contains a solid residue os $2^{gm}9$, consisting of bicarbonate of soda $2^{gm}0$, and free carbonic acid 2.2. The bathing establishment is very good. Compared with other Portuguese waters of the same class, Pedras Salgadas contains a larger amount of free carbonic acid, and a larger amount of arsenic.

Pedras Salgadas is largely used in dyspepsia and other complaints of the digestive organs, in rheumatism and in diabetes. The season is from 15th May to 30th September. The waters are bottled for export, and are largely used. Dose from 30 to 150 gm.

Campilho, Aguas Romanas, and Agua da Fonte Salus are similar in composition to Vidago. These waters are bottled and largely used both in Portugal and elsewhere. Chaves also belongs to the same class. It was known to the Romans first as *Aquæ Flaviæ,* and later on as *Aquæ Calidæ;* it is very hot, 68°; the solid residue is $2^{gm}2$. This source deserves to be developed. Moledo is hot and tepid, sodic carbonated and sulphurous; it is largely frequented by those suffering from rheumatism, syphilis and diseases of the skin.

Bem Saude is used only bottled: its composition is

moderately mineral, sodic carbonated and gaseous carbonated. It is useful in dyspesia.

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CHAPTER XVIII.

HEALTH RESORTS IN THE SOUTH CONTINENTAL OR THE TRANSTAGAN REGION.

Climate: cold and feebly moist in winter; hot and very dry in summer.

Spas: earthy.

A. CLIMATIC RESORTS.

The places of some interest from the climatic point of view are Beja and Evora. Notwithstanding the high fluctuation, and the variable range of temperature in summer, both the places have had the reputation of being useful in the treatment of some diseases of the respiratory organs, as consumption (1).

1. BEJA, AND EVORA.

BEJA: *continental-upland, most temperate, fluctuation high, evaporation excessive. Winter: moderately cold and feebly moist, equable, rainfall very moderate, evaporation moderate. Summer: moderately hot and very dry, variable, rainfall very scanty, evaporation excessive.*

Beja, the *Pax Augusta* of the Romans, and at present the capital of the district of Beja, is situated in $38°1'$ N. lat., at an elevation of 280 m., and at a distance of 75 km. from the sea, and 154 km. by rail from Lisbon. The vegetation in the environs consists of wheatfields, vines and olives. Its population is 10,115; and the number of households, 2,330.

The mean temperature in winter is $9°.50$; in spring, $14°.39$; in summer, $22°.54$; and in autumn, $16°.66$. The means of the maxima and the minima in the four seasons are: $13°.40$ and $6°.16$; $19°.67$ and $9°.63$; 30.01 and $15°.65$; and $21°.66$ and $12°.46$. The evaporation in winter is 183^{mm}, and in summer, 1036; and the relative humidity is 77.8 and 49.3 in the two seasons. The rainfall is $207^{mm}.2$ in winter, and $26^{mm}.9$ in summer. The number of days of rain is 111.2; of mist, 22.2; of snow, 9.4; and of frost, 2.3. The prevalent winds are N.W. and W.N.W. The mean velocity of wind is $12.^{km}48$.

Beja was formerly known as the «Asylum of the consumptives». Curvo Semedo, one of the Portuguese classifical medical writers, found Beja useful in «lung diseases and in chronic catarrh of the nose» (1), diseases which are not easily cured at Lisbon. This opinion is fully shared, at present, by the medical men resident in that city. The effects of the climate depend upon its greater dryness, and greater purity with comparative calmness of the air. Beja offers to the tourist some interesting Roman remains.

Evora, known in the time of the Romans as *Liberalitas Julia*, is the capital of the district of Evora. It is situated in $38°.31'$ N. lat., at an altitude of 420 m. and at a distance of about 75 km. from the sea, and at

117 km. by rail from Lisbon. In the mornings at 9 o'clock its temperature is lower than that at Beja by $0^{\circ}.6$, but at 15 o'clock it is higher by $2^{\circ}.75$, so that there is a greater variation from morning to afternoon. Its relative humidity is higher, but the rainfall is less. The most frequent winds are the N.W. and the N. It has enjoyed, like Beja, a reputation of being useful in some lung diseases. Besides other very important Roman remains, the aqueduct of Sartorius, 10 km. long beyond the fortifications, and the reservoirs in the city are of interest.

B. SPAS.

In the South Continental region there is only one source of some importance, namely, Moura. Aljustrel may be mentioned as a curiosity. Both are situated in the district of Beja.

2. MOURA.

Indifferent, tepid, and calcic carbonated.

Moura is situated at a distance of 59 km. by rail to the north-east of Beja. The waters have a temperature of $20^{\circ}.5$: they yield a solid residue of $0.^{gm}92$, consisting chiefly of bicarbonate of calcium 0.52; chloride of magnesium 0.18; bicarbonate of lithium and carbonic acid 0.15. They are bottled, and sold in all pharmacies. They enjoy a high reputation in diseases of the bladder and kidneys connected with gouty diathesis.

Aljustrel, a town to the south-east of Beja, and at a distance of 9 km. from the railway station of Carregueiro, has a spring named «Waters of St. John of the Desert»,

which contains a large quantity of iron, copper and arsenic. These waters have been used only as baths in leprosy, with apparently some benefit (2).

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CHAPTER XIX.

HEALTH RESORTS IN THE OCEANIC AND THE INSULAR REGION.

Climate: warm and dry in winter; hot and very dry in summer.

Spas: sulphurous.

I. THE OCEANIC AND THE INSULAR REGION.

The Oceanic and the Insular Region belongs to that section of climates (v. Ch. IX. 1) in which all or almost all stets are from the sea. This region may be divided into three *subregions:* 1) the Oceanic or the Lusitanian Sea; 2) the North Insular or the Archipelago of the Azores; and 3) the South Insular or the Islands of Madeira.

1) The subregion the *Lusitanian Sea* has a characteristically mild and equable climate due to the influence of the Gulf Stream. It is not subject, like the Mediterranean Sea, to the hot winds of the African desert, or to the cold winds from the snow-covered altitudes of Europe.

2) The *North Insular subregion,* or the Archipelago of the Azores, is under the influence of S.W. in winter and N.W. in summer. The Azores (from *astur,* and

açor, the great hawk or falcon) consists of nine islands with an area of 2,388 sq. km. They are situated between 36°.55′ and 39°.55′ N. lat., and between 25°.10′ and 31°.10′ W.Gr., and at a distance of 1,260 km. to the west of Lisbon. The highest and the only perpetually snow-covered altitude in the Portuguese State is the Peak, about 2,600 m. in the Island of Peak. All the islands are of volcanic origin, consisting of trachytis and basalt. They lie in the full course of the Gulf Stream; and they contain some craters and lakes of great beauty. The vegetation in some of the islands is luxuriant, from 80 to 90 per cent of the flora and also of the fauna is European. The indigenous species of plants have been estimated at 478, out of which about 40 are exclusive to the islands. Among the special cultivations are the pine-apple, tea, and tobacco. Where the islands have a sufficient elevation they present three zones: the littoral or the fruit zone; the central or the prairies; and the top or the zone of wood, heather and moss *(Sphagnæ).* Among the species peculiar to the island, two butterfly orchis *(Habenaria micrantha* and *H. longe-bracteata)* are limited to the mountains, whereas the littoral is characterised by the Azorian golden-rod *(Solidago azorica).* As regards the fauna, about 60 per cent of the molluscs are indigenous. The total number of inhabitants is 242,565 or 101 per sq. km.

The Azores were taken possession of between 1431 and 1453. They are divided for administrative purposes into three districts: Ponta Delgada, Angra, and Horta, named after the chief towns of the islands of San Miguel, Terceira, and Fayal. respectively. From the medical point of view San Miguel or St. Michael presents the

greatest interest, for Ponta Delgada is the most frequented town, and it possesses the best mineral sources. Its direction is from east to west; its area is 747 sq.km.; and it has a population of 127,726 or 138.8 per sq. km. A range of mountains runs along the whole length, forming distinct elevations at both ends, the eastern peak rising to a height of 1,700 m. On the western side a place termed Lagoa das Sete Cidades has four beautiful lakes, the largest of which is 2 km. in diameter.

3) The *South Insular subregion,* or the Islands of Madeira, is under the influence of the westerly winds. It consists of two inhabited islands: Madeira and Porto Santo; and three desert islands or the Salvages; the area of all of which is 815 sq. km. They lie between 32°.25′ and 33°.7 N. lat., and between 16°.39′ and 17°.16′ W.Gr., and at a distance of 970 km. to the south-west of Lisbon, and about 580 km. from the coast of Africa. They are also of volcanic origin. They are situated in the course of the Lusitanian branch of the Gulf Stream.

The island of Madeira, or «the island of Woods» and of a famous and exquisite type of Wine, was discovered in 1419 by João Gonçalves Zarco and Tristão Vaz. Its appearance from the sea is extremely picturesque and grand. Its direction is from east to west; it is 60 km. in length and 23 in breadth; and occupies an area of 787 sq. km. A chain of mountains of an imposing and striking aspect runs along the whole length; its highest peak, Pico Ruivo, is 2,020 m., and its mean elevation is 1,800 m. The flora of Madeira is sub-tropical; it approaches the megathermic zone of Köppen (v. Ch. VIII. 6). Its primitive woods have been

cut down, but nevertheless the vegetation is ample and luxuriant. Madeira has been divided by Lowe (1) into five botanical zones. The first, or the sub-tropical, rises to a height of 250 m. on the southern side and 100 m. on the northern, and is characterised by the presence of the cactus, banana, palms, anonas *(Anona squamosa)*, figs, carobs, sugar cane, vines and aloes. The second, or the temperate zone, rises up to 800 m.; it is the zone of cereals; among trees and shrubs there are the sweet gale *(Mirica Faya)*, the myrtle, oranges, citrons, apples, pears and also vines. The third, the wood or the pine zone, rises to 1,000 m. The fourth, or the zone of laurels, attains 1,500 m. And the fifth and the last is the zone of heather, 1847 m. The number of species peculiar to the island is about 100, among which are the Madeira thrift *(Armeria madeirensis)*, and the Madeira violet *(Viola paradoxa)*. In Madeira there are no mosses *(Sphagnæ)*, nor that profusion of ferns so characteristic of the Azores.

Among the fauna peculiar to Madeira is a wren *(Regulus madeirensis)*. There are several insects peculiar to it, many of which are wingless or with rudimentary wings, a peculiarity due, as it has been pointed out, to the struggle for life, for if they had wings they would be soon wafted out and drowned in the sea. The population of Madeira is 169,783 or 208 per sq. km.

One of the most interesting books on Madeira, historically considered, is by Bowdich, the French translation of which contains notes by Cuvier and Humboldt (2). Another book which is worthy of note, more as a curiosity, is a dithyrambic poem entitled

The Ocean Flower by Hughes, which contains the following lines:

> Knowest thou... the Island where these marvels meet?
> The peerless isle with all earth's treasures strewn,
> Knowest thou the Ocean flower so softly sweet?
> Oh! sure 'tis Madeira isle alone (3).

The general characters of the oceanic and insular *climates,* in many respects similar to those of the littoral and sea-breeze zones of the marine section (v. Ch. IX. 2), are: barometric pressure low; temperature warm, constant and very equable, the spring is comparatively cool and the autumn comparatively warm, the periods of minima and maxima being delayed; the relative humidity, as a rule, is great; there is a large amount of cloudiness and heavy rainfall; the velocity of wind is great; and the air is pure, free from dust, and largely charged with ozone, and saline elements. The intensity of the oceanic climate is exactly in proportion to the intensity of the velocity of winds.

The oceanic and the insular climates are *useful* in convalescence from many diseases, in weakness of the nervous system, anaemia, scrofula, and in persons with a tendency to consumption. They are also useful in chronic diabetes, in some cases of chronic catarrhs of the bladder, and in hay fever. They are contraindicated in gout, in haemorrhoids, biliary lithiasis, in advanced consumption, in chronic congestion of the stomach and intestines, in Bright's disease, and in advanced cases of heart disease.

A. CRUISING IN THE LUSITANIAN SEA, AND CLIMATIC RESORTS.

The most important climatic resorts in the insular region are Ponta Delgada and Funchal. The other places worthy of mention are Angra and Horta in the Azores, and Porto Santo in Madeira.

2. CRUISING AND BOATING IN THE LUSITANIAN SEA.

The usefulness of sea-voyages and sea-climates in diseases was well recognised by the Romans. Celsus recommends a person suffering from consumption to go on a long sea-voyage; if he cannot go on a long sea-voyage, he should cruise along the coast; and if he cannot go cruising, he should be carried to the seashore (1).

Medical men recommended, 50 or 60 years ago, long sea-voyages in consumption and in some other diseases; but this kind of treatment has fallen into disuse: firstly, because the voyages are now much more rapid, so that an invalid passes suddenly, within a few days, from one belt to another, which is very trying; secondly, because they are now, for the number of days spent on the sea, much more costly; and, lastly, because, under certain conditions, the climates of altitudes are preferable to those of the ocean.

The best way of spending a long time on the sea is either in a vessel fixed in a convenient harbour, or in a well-appointed yacht, in which its owner can select any climate he desires.

The best seasons for cruising in the Lusitanian Sea are the spring and the autumn. In winter there are sometimes gales from the south-west; and in summer there is the strong, and sometimes violent, Lusitanian north wind. On the whole, cruising in the Lusitanian Sea is less dangerous than in the Mediterranean Sea, and in the Bay of Biscay. The Bays of Cascaes, Setubal, and Lagos, and the harbours at Ponta Delgada, and Madeira, afford not only good shelters but also several points of interest on land. The mean temperature of the Lusitanian Sea is 16° on its northern limit, and 18° on the southern. One of the essential conditions of a sea-voyage is that the patient should not be subject to sea-sickness.

3. PONTA DELGADA.

Ponta Delgada: *insular, littoral, very saline-lowland, moderately warm temperate, fluctuation low or constant. Winter: most temperate and fleebly moist, very equable, rainfall very moderate. Summer: warm and feebly moist, equable, rainfall very moderate.*

Ponta Delgada, or the Fine Point, the capital of St. Michael, is situated on the southern side of the island and on the western shore of the Bay of Ponta Delgada, at the foot of the peak Agua de Pau, in 37°,45′ N. lat., or nearly 1°. lower than the latitude of Lisbon. It is built on a low beach, fronted by rocks, the streets being straight and wide. The Bay extends from Ponta Delgada to Galera, and is nearly 15 km. wide. The bananas, oranges, figs and pineapples grow freely. The population consists of 16,180.

The metereological station stands at an elevation of

17 m. The mean barometric pressure is 765.22. The mean temperature in winter is $14^{\circ}.97$; in spring, $14^{\circ}.98$; in summer, $19^{\circ}.34$; and in autumn, $18^{\circ}.12$; the mean annual being $16^{\circ}.85$. The means of maxima and minima in the four seasons are: $17^{\circ}.21$ and $12^{\circ}.51$; $17^{\circ}.47$ and $12^{\circ}.54$; $21^{\circ}.92$ and $16^{\circ}.91$; and $20^{\circ}.58$ and $15^{\circ}.17$. The mean relative humidity in winter is 78.5, and in summer, 77.0; the maximum occurs in November, 81.2, and the minimum in March and September, 72.1. The amount of evaporation during the year is $1281^{mm}.8$. The rainfall in 1904 was $804^{mm}.5$: $172^{mm}.5$ in winter and $191^{mm}.8$ in summer. In 1905 it was 296.8 in winter and 191.8 in summer. The number of days of rain is about 185. The prevalent winds are S.W., N.N.E., and N.E. Their mean velocity is $18^{km}.75$; the mean in winter being 22.05 and in summer 16.03. The study of the climate of Ponta Delgada and of the Azores is of great importance from the general or cosmic point of view. Hildebrandsson (1) has shown that the barometric pressure and the rainfall in the Azores and in Iceland are almost always quite opposite. There is a great resemblance between the climate of Ponta Delgada and of Mont'Estoril.

Ponta Delgada presents one of the best examples of a mildly warm, equable, moderately moist and healthy climate. It is useful in gastritis and inflammatory dyspepsia; in bronchial affections with a scanty expectoration; and in malarious cachexia. There are mosquitoes in the island, but, according to Dr. Sarmento, no anopheles (2). To the tourist it forms a good centre for pleasant excursions to the Valley of Furnas, and to Vila Franca.

Angra is situated on the southern side of the island

of Terceira, in 38°.39′ N. lat., the observatory being at an elevation of 44 m. Compared with Ponta Delgada, the barometric pressure and the mean annual temperature are lower; the mean relative humidity is greater; the number of days of rainfall is less, but the amount of rain is more. The most frequent winds are the N., the W., and the N.W.

Horta is the capital of Fayal and also of the province of the Azores. Its harbour is considered to be the safest in the whole archipelago. Its climate is similar to that of Ponta Delgada: the annual mean temperature is 17°.3; the rainfall is 1050^{mm}, and the number of days of rain 196. It is sheltered from the N. to N.E. winds, and from S.S.E. to S.W. winds. Its population is 6,099.

4. FUNCHAL OR MADEIRA.

Funchal: *insular, littoral and elevated amphitheatre, mountain and sea-breezes strong, moderately warm, yearly fluctuation low or constant, range equable. Winter: most temperate and dry, rainfall very moderate, evaporation (seasonal) excessive. Summer: moderately hot and dry, rainfall very scanty, evaporation (seasonal) very moderate.*

Funchal, commonly known as Madeira, is the capital of the island and of the district of Madeira. It lies on the slopes of a mountain with a southern aspect, in 32°.38′ N. lat. The houses rise in the form of an amphitheatre to the elevation of 150 m. The soil is dry. The bay is 8 km. wide; and the coast is formed by a series of rocky cliffs. From Fort St. George to Fort St. Lazarus there is a shingle beach, more than

a kilometer in length. Three rivers run through the town and empty in the Bay; in winter they form great torrents, but in summer they are mere rivulets.

The vegetation is superb. The plants of the subtropical zone thrive just as well as those of the temperate zone. The flowering shrubs are numerous and most luxuriant. The sweetest flowers are those of the *Olea fragrans*. Among the most striking trees and shrubs are the araucarias, the tree aloes, the wisterias, and the cactuses. The phenological phenomena take place much earlier than in Portugal. The leaves of the fig appear on the 25th February, whereas they appear on the 22nd March at Portimão, and on the 25th March at Mont'Estoril. The leaves of the vine appear on the 3rd March, and of the horse-chestnut on 12th March. The population of Madeira is 24,690.

The scenery of Madeira has been described by several writers. Camoens considers the island so beautiful that «Venus might build her dearest temple there».

One of the earliest, if not the first, writers to give a detailed account of the climate of Madeira is Thomas Heberden, brother of Dr. William Heberden, who published in 1751 the observations he had made in 1749 and 1750 (1). One of the best among the recent publications on the same subject is by Dr. Christmann, who gives important tables of the various meteorological factors from December 1864 to February 1899 (2).

The meteorological observatory stands at an elevation of 25 m. and at a distance of 107 m. from the coast. The mean temperature in winter is 15°.0, in spring 16°.0; in summer 21°.1; and in autumn 16°.1.

The means of the maxima and of minima in the four seasons are: 18°.4 and 9°.7; 15°.5 and 10°.7; 23°.8 and 15°.1; and 22°.7 and 14°.1. The yearly fluctuation is 7°.6, and the diurnal range 8°.37. The temperatures at 9 and at 21 o'clock are almost equal. The mean relative humidity in winter is 61.0, and in summer 64.4; the maximum being in October 68.9, and the minimum in March 57.1. The amount of evaporation is 1330^{mm} during the whole year: 302 in winter and 346 in summer. Taking 200^{mm} and 700^{mm} as the normal amount of evaporation in the two seasons (Ch. v. 10), the evaporation in winter is excessive and in summer very moderate. The total amount of rainfall is 732^{mm}: 212 in winter, and 12.6 in summer. The maximum of the fall is in autumn. The number of days of rain is 81, out of which 34 are in winter. There are no fogs, but the atmosphere is hazy towards the evenings in winter. There is no snow and no frost in the town. but there is a fall of snow on the mountains, 6 or 7 times during the year. The prevalent winds are the S. W. and the N. W. These winds are not always purely general winds; they are general winds modified by the topography of the land, and by the sea and mountain breezes. The breezes are well-developed: between 7 and 9 o'clock it is generally calm, between 9 and 16 o'clock there are sea-breezes, and during the night mountain breezes. The *leste* or the E. S. E. wind blows for about a week in July or in August, and brings some reddish impalpable powder; it is very hot, dry and disagreeable. After a snowfall on the mountains there is a current of cold air towards the town. The air is pure, sweet and free from dust.

The climate of Funchal in winter is most temperate

and dry. Several invalids and also healthy persons who go to Madeira in winter complain of a sense of chilliness. The thermometer does not explain this sensation, for the variations of temperature from morning to evening are reduced to their minimum. The sensation is due to the atmospheric humidity, provided of course that the velocity of winds is the same. There are two ways in which humidity in the air gives rise to a sensation of chilliness: one is by conduction and the other by convection or by radiation. At Funchal the daily variation of relative humidity shows a constant regularity: it diminishes up to 14 o'clock, when it remains stationary for about an hour, and then it increases, slowly at first, and rather abruptly at sunset. Supposing the temperature at sunset to be the same at 9 o'clock, the sudden rise of humidity gives a sensation of cold out of all proportion to its actual percentage. The other cause of the sensation of chilliness is radiation of heat from the skin when there is a fall in the amount of relative humidity. And the sensation is relatively greater if the day be clear and bright. It is often this sensation which has led some people to describe the climate of Funchal as damp or moist. The relative humidity in winter at Funchal, verified by several independent observers, is not very far from 61. The means at 9, 15, and 21 o'clock are: in December 65, 65 and 76; in January 63, 58 and 65; and in February 61, 58 and 62. These figures are certainly not those of a moist climate. Another reason to consider the climate dry is the amount of evaporation. Funchal has the highest amount of evaporation in winter, as compared with all other marine places in Portugal. In December, January and February the

evaporation is 95, 107, and 100 mm., respectively, whereas the figures for Lisbon for the same months are 28, 23, and 28. The differences are due partly no doubt to the higher temperature at Funchal, but they are also due partly to the comparative dryness of the air. The relative humidity in different parts of a town like Funchal varies very considerably. One of my friends, a medical man, who was subject to asthma, and resided at Madeira for about two years, found that if he came down below a certain level of the town he had an attack of asthma. He attributed this partly to the pressure of the air and partly to the change in the humidity. The presence of dense vegetation may give rise to an increased amount of humidity at that spot. Also a sudden current of cold air descending from the mountains may increase the relative humidity in certain valleys. The proximity of irrigated fields may also give rise to increased humidity. In warm temperate climates, the fall of two or three degrees of temperature gives rise to a sensation of cold out of proportion with the same amount of fall in a cold or very cold climate.

The water supply is pure and soft.

The inhabitants are healthy and vigorous, of moderate stature, with a brownish tinge in their features. The mortality is about 25 per mille, which is due to a large percentage of deaths among infants. The most commom diseases amongs adults are cutaneous affections and apoplexy. Tuberculosis is very rare. There are no endemic diseases, no intermittent or remittent fevers, no croup. In fact, Madeira is exempt from diseases common in warm countries, and little subject to those common in temperate regions.

The mean temperature at Arieiro, 1,700 m., from June to October, is 12°.2, or 8°.3 less than at Funchal; and at Poiso, 1,500 m., from July to November, is 13°.4, or 6°.4 less than at Funchal.

Compared with Ponta Delgada, the barometric pressure at Funchal is somewhat lower; the annual and the winter temperatures are higher by about 1°; and the summer is warmer by 1°.5; the evaporation is greater; and the rainfall and the velocity of winds are less.

With reference to Las Palmas the mean temperature at Funchal is 1°.2 less; and the mean relative humidity is also 3.1 per cent less.

There is no place the climate of which has attracted more attention for therapeutic *uses* than Funchal; and the great majority of writers on the subject are British. In 1774, Gregory remarks that Madeira is useful to all those who require an equable climate (3): in 1775, Fothergill recommends it in consumption (4); and these writers are followed by several others. But it is to Sir James Clark that the island owes its great reputation (5). The best monograph on the climate of Madeira is by Barral (6), of Lisbon. Among German works Goldschmidt's book deserves a mention (7).

Funchal has the best insular climate in Europe. «When we take into consideration», says Clark, «the mildness of the winter and the coolness of the summer, together with the remarkable equality of temperature throughout the year, we may safely conclude that the climate of Madeira is the finest in the northern hemisphere» (pg. 271). And this opinion is confirmed by every competent observer. Therapeutically considered, Funchal is sedative and tonic. It is extremely

useful to many invalids, to the old and the feeble, and to the weakly and anaemic children. It cannot be recommended to the healthy and the strong from the cold climates, for they will find its heat rather relaxing. Those coming from the tropical climates can utilise it as an intermediate station.

The climate of Funchal is useful in catarrhal forms of chronic phthisis, and in chronic catarrh of the larynx. It is also beneficial in chronic pleurisy, emphysema with scanty expectoration, and in malarious fevers. It is especially useful in scrofula. It is contra-indicated in cases of consumption with high and continuous fever, with acute softening and profuse expectoration. It must be avoided by the rheumatic, and by those who have a tendency to intestinal flux. Some cases of asthma do well, others become worse. The proximity of all places planted with sugar cane are to be avoided, for, owing to irrigation, there is greater dampness of the air. The most trying season is the spring. «From my own observation», says Mason, «I should say that as soon as any invalid finds that he becomes better during a *Leste* (east-wind) it would be advisable for him to seek a drier climate without delay» (8).

To prevent radiation of heat from the skin or the sensation of chilliness, on a bright sunny day, there is nothing better than a shawl over the shoulders or a light but somewhat dense overcoat. This may seem a very trite remark, but it is necessary to make it, for there are some people who go about with silk and linen garments, simply because the day is bright, and then complain of cold. It would be good if people were guided in their dress not only by the dry or the ordinary thermometer, but also by the wet-bulb

thermometer, for, given the same degree of temperature, there is a greater sensation of chilliness in winter when the evaporation is higher.

The new arrivals are sometimes subject to diarrhoea due to two causes: from immoderate consumption of fruit, and from the softness or from the absence of lime in the drinking water. The first cause is easily avoided by avoiding fresh fruits or by eating them, when possible, cooked; and the second, by adding a tabloid of carbonate of lime or soda to a tumblerful of water.

The island of Madeira is blessed with a variety of climates. By changing the residence to higher elevations, it can be inhabited by the invalid throughout the year.

Arieiro and Poiso have been recommended as suitable places for sanitariums. Terreiro da Lucta, 1,000 m., is connected with Funchal by a mountain railway.

Porto Santo, the port of the island of Porto Santo or the «Holy Port», is situated on the eastern coast, sheltered from the S.E. and the N.E. winds through the west. Its climate is soft, sunny and almost tropical.

B. SPAS.

There are several sources of great importance in the valley of the Furnas in the island of San Miguel. The principal sources are Caldeira Grande, and Lombadas. The other sources also in the Furnas are: Quenturas, and Agua Santa.

5. FURNAS: CALDEIRA GRANDE.

Sulphurous, very hot, moderately mineral, sodic carbonated and muriated, sulphureted, and gaseous carbonated.

The mineral waters known as Furnas or «Caves» are situated in a spacious valley, surrounded with high mountains, at a distance of 45 km. to the north-east of Ponta Delgada, and at a mean elevation of about 250 m. The valley is very fertile and rich in vegetation: the mean temperature in winter is 12°. The air is pure, but somewhat moister than that of Ponta Delgada. In winter the days are pleasant and agreeable, but the nights are cold.

These waters have been known since the commencement of the XVII. century. Dr. Gourlay (1) was one of the earliest medical men to analyse some of these waters. There are several classes of springs in the valley and in its neighbourhood, some of which are thermal and others athermal. The important ones are sulphurous or chalybeate. A full description of the composition of these waters is given by Fouqué, and of their uses, by Cabral (2).

The sulphurous contain bicarbonate and chloride of sodium, with a variable amount of sulphur and of free carbonic acid. The chief sources of this kind are Caldeira Grande, Quenturas, and Agua Santa.

Caldeira Grande has a temperature of 98°.3. It yields a solid residue of $1^{gm}81$, consisting chiefly of carbonate and chloride of sodium, with a considerable quantity of carbonic acid and of sulphureted hydrogen.

Quenturas is hot, 48° in temperature, and somewhat sulphureted. Its total solid residue is $1^{gm}01$.

Agua Santa or the Holy Water has a temperature of 88°, and a solid residue of $0^{gm}725$.

The chalybeate waters of Furnas contain besides iron, alkaline bicarbonates and chlorides, some free carbonic acid, and a trace of sulphur. As specimens of these sources are Agua Azeda, Agua Fria, and Agua do Sanguinhal.

Some waters, such as Pedro Botelho, Caldeira do Lago das Furnas, and others, develop free hydrochloric or sulphuric acid on exposure to the air.

The uses of all the sources have not yet been specialised. Caldeira Grande and some other sulphurous sources are used chiefly in rheumatism, in paralysis, and in some skin diseases. Quenturas is recommended in rheumatoid paralysis, chorea and psoriasis. And Agua Santa is efficacious in chronic inflammation of the larynx, and in chronic bronchitis. The baths are frequented chiefly in summer, but they are open throughout the year.

6. LOMBADAS.

Simple, aerated table-water.

Lombadas or the «Upland» is situated in a small valley not far from Furnas. It yields the best kind of the Portuguese table waters. It contains in 1000 gm. $1^{gm}748$ of carbonic acid and a solid residue of 0.168, composed chiefly of carbonate of soda, chloride of sodium, and peroxide of hydrogen 0.003. This water is largely used in Portugal and elsewhere.

C. SEA-BATHSING RESORTS.

7. SEA-BATHING RESORTS IN THE INSULAR REGION.

Sea-baths are taken both at Ponta Delgada and at Funchal, but these towns do not present as good shores as some other parts of the islands.

The mean temperature of the water at the Azores is 18°; and at Madeira, 19°. The mean at Funchal in winter is 16°; and in summer, 20°.0. The specific gravity of the water at Ponta Delgada is 1.0275; and at Funchal 1.0280; the former being 0.0005, and the latter 0.0001 higher than the mean on the shore of Portugal.

Owing to the high temperature of the water, sea-baths can be taken throughout the year.

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CHAPTER XX.

CLASSIFICATION OF THE HEALTH RESORTS; GENERAL AND CONCLUDING REMARKS.

Portugal is a microcosm of all the best species of temperate climates, and of all the classes of spas.

I. HEALTH RESORTS AND PLEASURE RESORTS.

All resorts may be classed, as regards uses, into two main groups: those frequented for therapeutic purposes; and those for mere pleasure or relaxation from ordinary work. Some climatic resorts, a few spas, and many sea-bathing stations are used both as health and as pleasure resorts, and often do not satisfy a large percentage of people who frequent them, for the requirements of an invalid or a valetudinarian are somewhat different from those of a healthy person bent upon pleasure. An invalid needs complete rest, and freedom from all worries. If in a hotel, his food demands special attention. A tourist requires, besides good accommodation, something to amuse him: golf, boating, fishing, mountaineering, skating, lawn tennis, or any other sport in which he takes special interest. Good and soft music is relished by all.

Nature often supplies, in some diseases, the required climate. Diseases contracted in winter often improve in summer; and those contracted in summer often improve in winter; but when this is not the case, or when the improvement is slow, the medical man has to intervene and choose a suitable climate.

An annual or periodical change of air is one of the best means for the preservation or improvement of general health. It has been noticed that those who remain fixed at one place are more liable to some of the ordinary diseases than those who travel or frequently change from one place to another.

Many laymen, and even a few medical men, believe that a climate is only good if it is useful in consumption, as if there were no other diseases which required a change of climate.

2. CLASSIFICATION OF CLIMATIC RESORTS, AND THE CHOICE OF A SUITABLE ONE.

Climatic resorts may be grouped according to the classes to which they belong; to their species and types; to the seasons in which they are useful; and to their special uses.

I). CLASS, AND SUB-CLASS.

Insular: Funchal, Ponta Delgada.

Marine: a) On the littoral or saline zone: Granja and Espinho, Figueira da Foz, Lagos, Mont'Estoril and Cascaes, Oporto (Foz), Setubal, Viana do Castelo; b) in the sea-breeze zone: Caldas de Monchique, Cintra, Lisbon, Oporto; and c) in the inland marine wind zone: Bom Jesus do Monte, Bussaco, Coimbra, Gerez, Sei-

xoso, Guarda. Some of these inland places are also exposed to feeble sea-breezes.

Continental: Beja, Evora, Pedras Salgadas.

Altitude: The basis is the position of the hotels or sanitariums: a) high (above 1200 m.): Covilhã-Estrela 1530; b) moderate (1200-700 m.): Guarda 1,039, Manteigas 775; c) low (700-400 m.): Unhaes da Serra 657, Pedras Salgadas 580, Gerez 468, Bom Jesus do Monte 400.

Forest or *sylvan:* Bom Jesus do Monte (400 m.), Bussaco (357), Caldas da Rainha (40), Caldas de Monchique (250), Cintra (207).

Urban: Lisbon, Oporto.

II). Species: Based upon the two main seasons.

In *winter*.

a) Most temperate and dry: Madeira.

b) Most temperate and feebly moist: Ponta Delgada.

c) Moderately cool temperate and feebly dry: Lagos.

d) Moderately cool temperate and dry: Setubal.

e) Cool temperate and feebly dry: Figueira da Foz, Mont'Estoril and Cascaes, Lisbon.

f) Cool temperate and feebly moist: Caldas de Monchique.

g) Moderately cold and feebly moist: Beja, Coimbra.

h) Moderately cold and moist: Evora, Oporto, Viana do Castelo.

i) Cold and moist: Bom Jesus do Monte, Bussaco, Cintra.

j) Very cold and moist: Covilhã-Estrela, Guarda, Poio Negro.

In *summer*.

a) Moderately warm temperate and very dry: Covilhã-Estrela, Guarda, Poio Negro.

b) Moderately warm temperate and feebly moist: Bom Jesus do Monte, Bussaco, Cintra.

c) Warm temperate and feebly moist: Gerez, Granja and Espinho, Oporto, Ponta Delgada.

d) Warm temperate and feebly dry: Viana do Castelo.

e) Warm temperate and dry: Coimbra, Mont'Estoril and Cascaes.

f) Moderately hot and dry: Caldas da Rainha (?), Caldas de Monchique, Figueira da Foz, Funchal, Pedras Salgadas, Seixoso.

g) Moderately hot and very dry: Beja, Lagos, Lisbon, Setubal.

Besides these 17 species there are several others in the intermediate seasons of spring and autumn. The cold and dry which is one of the most useful species is found at Estrela in April and in October.

For the meaning of words used in the description of the species the reader is referred to the chapters on temperature (§ 9) and humidity (§ 10). At some of the stations there are no meteorological observatories, and it is possible that their characters may have to be modified with more accurate observations. The mean annual temperature of almost all the resorts is most temperate.

Besides the classes and species each resort is further characterised by its *variety* or *type* based upon the other factors of climate. Rainfall and evaporation, taken as examples of typical characters of climatic resorts, may be classified thus:

1) *Rainfall in winter:*

a) Excessive (above 450 mm.): Oporto.

b) Moderate (450-300 mm.): Cintra, Guarda.

c) Very moderate (300-150 mm.): Beja, Coimbra, Figueira da Foz, Funchal, Lagos, Lisboa, Ponta Delgada.

2) *Rainfall in summer:*

a) Very moderate (300-150 mm.): Ponta Delgada.

b) Scanty (150-75 mm.): Coimbra, Guarda, Oporto.

c) Very scanty (below 75 mm.): Beja, Cintra, Figueira da Foz, Funchal, Lagos, Lisbon.

1) *Evaporation in winter* (for the basis of classification see Ch. v. 10).

a) Excessive (above 200 mm.): Coimbra, Funchal.

b) Moderate (between 200-100 mm.): Beja, Guarda, Oporto.

c) Feeble (below 100 mm.): Lisbon.

2) *Evaporation in summer:*

a) Excessive (above 700 mm.): Beja, Coimbra, Guarda.

b) Moderate (between 700-350 mm.): Funchal, Lisbon.

c) Feeble (below 350 mm.): Oporto.

III). SEASONS.

A climatic resort is at its best during certain seasons or portions of seasons.

1) In *winter:* Coimbra, Evora, Figueira da Foz, Funchal, Lagos, Lisbon, Mont'Estoril and Cascaes, Ponta Delgada, and Setubal.

2) In *summer:* Bom Jesus do Monte, Bussaco, Caldas de Monchique, Caldas da Rainha, Cintra, Covilhã-Estrela, Figueira da Foz, Gerez, Granja and Espinho, Guarda, Manteigas, Mont'Estoril and Cascaes, Oporto (Foz), Pedras Salgadas, Seixoso, Unhaes da Serra, Viana do Castelo, and all the other sea-side resorts.

The summer resorts are much more numerous than the winter for they are in greater demand by the natives of the country. The winter resorts are usually

very pleasant in the early part of the spring, and the summer resorts in early autumn.

IV). Uses.

Physiologically considered the littoral resorts in the North Atlantic region are very protective, whereas those in the Lusitanian and the Mediterranean regions are protective.

With the exception of Madeira, Mont'Estoril, Guarda, and Estrela, the special therapeutic uses of other climatic resorts have not yet received much attention. It is not easy, therefore, to classify all the resorts according to their special uses. All of them partake of the general characters of the class to which they belong. In certain cases of consumption, Estrela, Guarda, and Madeira are very useful; in convalescence from almost all acute diseases, in chronic catarrhs of the respiratory organs, and in chronic rheumatism, Mont'Estoril is very beneficial; and in almost all tropical diseases and in malarial complaints, Madeira, Mont'Estoril, and Ponta Delgada may be recommended.

In *choosing* a climatic resort it is necessary to take into consideration the constitution and the temperament of the patient, his susceptibility or idiosyncrasy to certain climatic conditions, and the character and the stage of the disease. The main principle consists in finding out what has been the climatic cause of the original disease, and what are the conditions which prevent the recovery; and then to find out a station with, within certain limits, opposite characters. For instance, if a foggy and damp climate brings on an attack of gout, the patient avoids the attack by a change to a dry climate with a good deal of sunshine; if a moist or a dry climate keeps up a chronic laryngitis,

the main indication is to select a climate the reverse of that which keeps up the irritation; and if a liver complaint has arisen from a residence in the tropics, the main indication is to send the patient to a temperate climate. It has to be remembered, however, that a climate may be useful in the primary disease but not in some of its complications.

It is a mistake to judge the value of a resort merely by its latitude. A lower latitude does not necessarily mean a better climate in winter. Two stations placed in the same latitudes and in the littoral zone have quite different climates if one is under the influence of the Gulf Stream and the other under the influence of snow-topped mountains. Such is actually the case in some parts of the Iberian Peninsula. In a similar manner, mere height is no indication to the nature of the climate.

A climate has to be regulated or dosed according to the needs of the invalid. To change a patient suddenly to a very stimulant or to a very sedative resort is injurious and sometimes even fatal. The climate must be considered in the same way as a drug or as a diet. When the vital functions are at their lowest ebb and the power of resistance is extremely feeble, an invalid requires, as a rule, a warm or even a hot and an equable climate; but when the powers of resistance become greater a temperate climate is more useful. Besides a warm or a hot temperature, a moderate dryness or a moderate moisture, feeble winds, and a good deal of sunshine are very useful in a weak patient. Such a climate may be compared to the milk diet. The climates which are contra-indicated are those which are very unstable and very irregular. A climate which

contains, proportionately, more moisture has to be more equable, than one which is, proportionately, more dry; for the sensation of heat does not depend only upon temperature, but also upon the moisture. Also when the cold and moisture are great the winds have to be feeble.

The climate in which the invalid was born and bred has also to be taken into account, for if he was born in a very dry climate he does not feel very comfortable in a moist one, and vice-versâ.

The principles in the selection of a resort as a prophylactic are similar to those which guide in the selection of one for a cure. But a climate which is good as a prophylactic is not necessarily good when the disease is fully developed, for it may take a form in which some of the climatic elements useful as a prophylactic may not be favourable to its cure. A disposition to bronchitis, for example, may be treated by sending the patient to a climate with an equable temperature with a moderate amount of humidity, but if the disease takes, when developed, an irritative form with a dry cough, or shows a tendency to bronchorrhœa with relaxation of bronchial mucous membranes, the two forms will require different climates for their cure.

From all this it is clear that there are two essential conditions for the successful treatment of a disease by climate: the first is to know exactly the requirements of a patient, which is comparatively easy; the second is the selection of a resort, which is not always easy, for a medical man cannot make himself personally acquainted with all the resorts, and it is difficult to convey by mere description the exact condition of one

climatic resort as compared with another of the same class and species.

It is not enough for an invalid to change a climate; it is essential that he should place himself under proper local medical supervision and to follow a regular regimen. Change of climate is a great help, but not always enough to effect a cure. Some invalids imagine that if they go to a good climate they can do just what they like, and sometimes contract fresh diseases.

No definite rules can be laid down in the selection of pleasure resorts. A good deal depends upon individual tastes and inclinations. Those who reside in large cities are better off if they go to the mountains in summer and to the sea-side in winter, after a preliminary rest of a few days at a hill, or at a forest resort, for a sudden change to a high altitude or to the sea-side is often injurious. The essential conditions of a successful tour are: a good climate, and a complete change from the usual surroundings.

In persons past middle age, and in young children, the best way of spending a whole year in Portugal is to reside in the most temperate sea-side resorts in winter, and in moderate or low altitudes, situated inland, in summer. In middle-aged persons an ideal way of spending a year is to winter in the moderately temperate littoral zones, to spend the spring and the autumn in the plains away from the sea-breeze zone, and to pass the summer in high altitudes. The residents of Lisbon and Oporto would be far better off in summer in the Serra of Estrela than on the sea-side, for,

La montagne fait l'homme,
La ville le consomme.

Or, «the mountain makes the man, the city consumes him».

Generally speaking, the resorts in the saline zones of the Lusitanian, the Mediterranean, and the Insular regions are most useful in winter; those in the saline zone of the North Atlantic region, from late spring to early autumn; those in the plains under sea-breeze zones, in regions below 40° latitude, in spring and in autumn; those in altitudes, in summer; and those in woods or forests, also in summer.

3. CLASSIFICATION OF THE SPAS, AND THE CHOICE OF A SUITABLE ONE.

The spas may be classified on the bases of their geographical and geological distribution: their physical properties and chemical composition; their uses; and the seasons in which they are useful.

I). GEOGRAPHICAL AND GEOLOGICAL DISTRIBUTION.

The principal alkaline springs are limited to the N. Continental region; the sulphur springs of primary or volcanic origin are found in the Azores and in the N. Atlantic region; and the saline, and the sulphur springs of recent or tertiary origin are found mainly in the plains of the Lusitanian region.

II). PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION.

1). Based upon *temperature* the mineral springs are: a) hyperthermal or hot (above 33°.8): Furnas (98°.3-16°), Vizela (65°-15°), Gerez (48°.2-18°), Cucos (37°.5-32°.2), and Caldas da Rainha (34°.5); b) hypothermal or warm (33°.8-25°): Monchique (32°.5), Caldelas (32°.5-23°), Taipas (32°-28°), Estoril (28°), and Poças (27°); c) protothermal or tepid (25°-18°): Vidago 23°.5-17°.6),

San Paulo (22°.5), Moura (20°.5), Pedras Salgadas (19°.12), and Entre-os-Rios (18°.5-13°.5); d) athermal or cold (below 18°): Melgaço (15°), and some of the spas at Vizela and Entre-os-Rios.

2). As regards the *total solid residue,* there are only two spas which are hypermineral or very mineral, namely, San Paulo and Vidago; whereas all the others, with the exception of the indifferent or the simple thermal waters, are mesomineral or moderately mineral.

3). Upon the basis of *chemical* substances the various spas may be grouped in the following 8 *classes:*

Indifferent or *Simple Thermal:* Caldelas, Entre-os-Rios, Gerez, Luso, Monchique, Taipas, Vizela.

Sulphurous: Caldas da Rainha, Furnas (Caldeira Grande), San Paulo, Taipas, Vizela.

Muriated or *Common Salt:* Caldas da Rainha, Cucos, Estoril, Furnas (Caldeira-Grande), Poças, San Paulo. Only San Paulo contains a sufficient amount of salt to constitute a brine bath, it contains also the largest amount of bromine and iodine.

Alkaline: a) alkaline and carbonated or acidulous: Pedras Salgadas, Vidago; b) mixed alkaline: Melgaço; c) alkaline and muriated: Luso; and d) alkaline and lithiated: Vidago.

Bitter or *Sulphated:* Charniche.

Earthy or *Lime:* a) carbonated: Melgaço; b) sulphated: Curia.

Iron or *Chalybeate:* Melgaço, Montachique.

Simple Aerated: Lombadas and several others.

Among spas containing special constituents may be mentioned the following: a) arsenical salts: Pedras Salgadas, Vidago; b) fluorides: Gerez; c) silica and silicic acid: Furnas (Caldeira Grande), Vidago; and

d) radioactive substances: Caldelas, Cucos (*lamas* or mud), Gerez, and Vidago. It may be mentioned that all the sources have not yet been examined for their radioactivity.

III). Uses.

The following are some of the diseases in which the various spas are specially useful:

Anaemia and chlorosis: Melgaço.

Diabetes: Melgaço, Gerez.

Diseases of the digestive organs: a) dyspepsia: Vidago; b) enteritis: Caldelas.

Diseases of the kidney and bladder: Luso, Moura.

Diseases of the respiratory organs: Entre-os-Rios, Agua Santa (Furnas).

Diseases of the skin: Taipas.

Gout and gravel: Cucos, Curia, Estoril.

Liver complaints: Gerez.

Paralysis: Furnas (Caldeira Grande).

Rheumatism: Caldas da Rainha, Estoril, Monchique, San Paulo, Vizela.

Syphilis: Caldas da Rainha, San Paulo, Vizela.

Uterine complaints: Caldas da Rainha.

IV). Seasons.

All the baths are taken in summer, early autumn and late spring. Some baths, as Caldas da Rainha, Estoril, San Paulo, and Vizela, are available almost throughout the whole year. There are no spas on the Continent where mineral baths can be taken with greater advantage in winter, in the treatment of rheumatism and gout, than at Estoril and San Paulo (Lisbon).

In *choosing* a spa attention has to be paid not only to disease but also to the age of the patient, and to the climate in which the spa is situated. As a rule, mineral

waters are more useful in young adults and in middle-aged persons. The best time for the northerners to frequent the spas in Portugal is, generally speaking, from 20th May to 15th June, or from 20th October to 15th November. If a mineral spring in one country does not, after a fair trial, give the desired result it is better to try another spring of the same class in the same country or elsewhere. Spas may be used as prophylaxis, but, in such cases, climates are preferable. When hot baths are taken in winter it is desirable to have them in a residential establishment.

Seixoso may be mentioned as a special resort for grapecure.

4. CLASSIFICATION OF THE SEA-BATHING RESORTS, AND THE CHOICE OF A SUITABLE RESORT.

The sea-bathing resorts may be classified according to the physical properties of the water, and according to the climate of the place or the seasons in which the baths may be taken.

I). Composition.

The mean temperature of the surface water of the Lusitanian Sea is 17°; it varies from 14°.5 in spring to 20°.5 in autumn; and it is warmer in winter than in spring. Owing to the influence of the Gulf Stream and to the configuration of the coast, the water is often warmer in summer and autumn in the portion of the coast above the Tagus than below it. Except where there are outlets of rivers, the chemical composition of the water appears to be more or less uniform. The shores directly exposed to the north have, in summer,

stronger waves or a stronger sea-influence than those exposed to the south.

II). Seasons.

As regards climate the best places for sea-baths in summer and in early autumn are Figueira da Foz, Granja and Espinho, and Mont'Estoril and Cascaes; and the best in winter are Funchal, Mont'Estoril, and Ponta Delgada.

The *choice* of a suitable sea-bathing resort depends mainly upon the condition of the invalid. If very weak or nervous it is better to avoid sea-baths altogether, or to take them duly warmed at home. Many persons believe that sea-bathing and sea air are always good. This is a mistake. Sea-baths put a great strain upon the circulatory, digestive, and secretory systems, and, therefore, in some cases, do more harm than good. For a weakly person, used to town-life, it is necessary to repose for a short time at some inland place before commencing sea-baths.

GENERAL AND CONCLUDING REMARKS.

Portugal forms a distinct geographical, a distinct botanical, and a distinct climatic unit; and it offers a few unique and some very important health resorts to the invalid, and numerous attractions to a tourist.

The six climatic regions of Portugal afford an excellent illustration of the harmonious coordination between the prevalent winds and the geographical features on the one hand, and the distribution of temperature, humidity, rainfall, mists, clouds, sunshine, the surface currents of the Lusitanian Sea, and the vegetation on the other;

and also between the climate of each region on the one hand, and the physical and moral development of the inhabitants, the pathological effects, and the therapeutic uses on the other. And, lastly, the whole country presents a harmonious contrast with the highlands of Spain.

Portugal possesses almost all the classes and sub-classes of climates, being particularly favoured in its insular, marine, mountain, and sylvan. It forms a microcosm of all the cold, temperate, warm and hot climates of Europe, extending from the southern coast of Ireland down to the northern shores of Africa. It has some varieties of climates which are quite unique: there is no zone on the Continent which has such a typical climate as the Portuguese Riviera, and no islands within the latitudes of Europe with such a typical climate as the Azores. Judged by its phyto-geography, the subregion Central Estremadura, in which Lisbon and the Portuguese Riviera are situated, has the mean temperature of the world on the Atlantic coast, and coincides with the line of junction of the floras of the northern and the southern botanical provinces of Europe. Judged by the phenology, the same subregion represents the characteristic climatic condition of two springs lasting from the middle of October to middle of June, and a summer of the remaining four months. The country possesses all the classes of spas, being particularly rich in its alkaline, indifferent, sulphurous and muriated sources. No other country in Europe can claim all these advantages.

There are nowhere climatic resorts of their class comparable to Madeira, Mont'Estoril, and Lisbon in winter, and to Bussaco, Cintra and Bom Jesus do Monte

in summer; neither spas comparable to Gerez in liver complaints, Vidago in dyspepsias, and Curia in gout; nor such beautiful seashores, with such warm water for sea-bathing both in summer and winter, as Granja, Figueira da Foz, and Estoril. The natural health-giving resources of Portugal are indeed marvellous, but it has to be confessed that some of them remain unexplored. Vale do Conde in Estrela, and Monte Regina in Arrábida would be largely frequented by persons requiring a change of air if they had good hotels. For the consumptive, a well-appointed sanitarium in the Serra of Estrela for the fair season, and another, under the same management, in a select spot in the Serra of Arrábida for the wet season, would be the very best means imaginable for the climatic treatment of this fell disease. Estoril and San Paulo would be the best Continental spas for rheumatism and gout, in winter, if they had residential balneological establishments.

There is a belief among some people that Portugal is not easily accessible, and a recent writer states that the country is wanting in resources for the comfort of a foreigner. This, no doubt, was true twenty years ago, but things have very considerably improved during the last few years. There are now not only more rapid and more frequent communications, both by sea and by land, with other countries, but also many new branch railways and motor car services which render all the important health resorts, and many interesting parts of the country easily accessible. There are also some new hotels, which, considering their tariffs, are as good as are to be found elsewhere. It may be added that strenuous efforts are made by the government, by public associations, and by private individuals, to meet

the special requirements of the foreigners in general, and of the British in particular; and important improvements in all directions may be confidently expected during the next few years.

Portugal offers great attractions to a British tourist. It ought to claim his attention on account of the very old standing political and commercial ties, and of the British communities settled in Oporto and Lisbon for more than 150 years; it ought to attract him as the country where Fielding is buried, where Southey and Byron spent some part of their lives, and where Wellington fought some of his battles; and it ought to excite his curiosity as a country of glorious achievements in the past, and of promises of a great and bright future.

The country offers attractions to persons of various tastes: the artist can contemplate to his heart's content the numerous and charming landscapes, the beautiful and wonderful scenery of the valleys of the Mondego, the Douro and the Zezere, and the finest woods of the whole of Europe; the architect can admire the characteristic ecclesiastical and conventual monuments such as those of Batalha, Alcobaça, Thomar, and Belem; the archeologist can examine many interesting relics of the prehistoric period in various parts of the country, and of the Roman and the Moorish civilizations at Cintra, Evora, Coimbra and several other places; the historian can visit the places of birth, or see the monuments, relics, or works, as the case may be, in connection with Albuquerque, Bartholomew Dias, Cabral, Camoens, Castro, Garcia d'Orta, Herculano, Ignez de Castro, José Estevão, Magalhães, Marquis of Pombal, Nuno Gonçalves, Pedro Nunes, Prince Henry, Queen Leonor, Queen Isabel, St. Antony, St. Francis Xavier, Vasco

da Gama, and a host of other famous men and women ; and the geologist, the minerologist, the botanist, the ichthyologist, the entomologist, the ornithologist, and the anthropologist, can each investigate, to his intense pleasure and satisfaction, the ample materials which nature places so lavishly at his disposal, and he can frequent also the museums devoted to these subjects in the three university centres of Lisbon, Coimbra and Oporto. Portugal, with reference to its natural resources, is a veritable paradise of Europe.

Lastly, both the invalid and the tourist will find in Portugal a country blessed with a pure and delicate air, and lovely flowers in all the seasons; a climate which is admirably the most temperate, the most constant, and the most equable within the latitudes of the whole of Europe; and a people always charming for their affability and kindliness to all foreigners.

INDEXES.

INDEX I.

ALPHABETICAL LIST OF AUTHORS.

The numbers in italics indicate pages under References.

INDEX II.

ALPHABETICAL LIST OF THE PRINCIPAL CONTENTS.

Note. — For the sake of brevity, such particles as *of*, *its*, *and*, have been frequently omitted.

A.

B.

C.

D.

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H.

I.

M.

V.

W.

APPENDIXES

APPENDIX I.

WEIGHTS AND MEASURES.

The following tables show the British equivalents of the metrical system of weights and measures. The correspondence of the higher temperatures is necessary on account of the mineral waters.

TEMPERATURE.

Centigrade (cent.) and Fahrenheit (Fahr.) degrees.

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
100	212	82	179.6	64	147.2
99	210.2	81	177.8	63	145.4
98	208.4	80	176	62	143.6
97	206.6	79	174.2	61	141.8
96	204.8	78	172.4	60	140
95	203	77	170.6	59	138.2
94	201.2	76	168.8	58	136.4
93	199.4	75	167	57	134.6
92	197.6	74	165.2	56	132.8
91	195.8	73	163.4	55	131
90	194	72	161.6	54	129.2
89	192.2	71	159.8	53	127.4
88	190.4	70	158	52	125.6
87	188.6	69	156.2	51	122.8
86	186.8	68	154.4	50	122
85	185	67	152.6	49	120.2
84	183.2	66	150.8	48	118.4
83	181.4	65	149	47	116.6

TEMPERATURE (*cont.*).

Cent.	Fahr.	Ceni.	Fahr.	Cent.	Fahr.
46	114.8	27	80.6	8	36.4
45	113	26	78.8	7	44.6
44	111.2	25	77	6	42.8
43	109.4	24	75.2	5	41
42	107.6	23	73.4	4	39.2
41	105.8	22	71.6	3	37.4
40	104	21	69.8	2	35.6
39	102.2	20	68	1	33.8
38	100.4	19	66.2	Zero	32
37	98.6	18	64.4	— 1	30.2
36	96.8	17	62.6	— 2	28.4
35	95	16	60.8	— 3	26.6
34	93.2	15	59	— 4	24.8
33	91.4	14	57.2	— 5	23
32	89.6	13	55.4	— 6	21.2
31	87.8	12	53.6	— 7	19.4
30	86	11	51.8	— 8	17.6
29	84.2	10	50	— 9	15.8
28	82.4	9	48.2	— 10	14

MEASURES OF LENGTH.

Kilometers (km.) Meters (m.) Millimeters (mm.) and English Miles, Feet and Inches.

Metric.	English	Metric	English	Metric	English
km.	miles	m.	feet	mm.	inches
1	0.6	1	3.2	1	0.039
2	1.2	2	6.5	2	0.079
3	1.8	3	9.8	3	0.118
4	2.4	4	13.1	4	0.157
5	3.1	5	16.4	5	0.197
6	3.7	6	19.6	6	0.236
7	4.3	7	22.9	7	0.275
8	4.9	8	26.2	8	0.315
9	5.5	9	29.5	9	0.375
10	6.2	10	32.8	10	0.394
50	31	500	1640.4	700	27.559
100	62.1	1000	3280.8	800	31.496

MEASURES OF CAPACITY.

Cubic centimeters (c. c.), Liters (l.) and Imperial Fluid ounces (fl. oz.), Fluid drachms (fl. dr.) and Minims (min.).

Metric	Fl. oz.	Fl. dr.	Min.	Metric	Fl. oz.	Fl. dr.	Min.
1 c.c...	—	—	17	8 c. c. ..	—	2	15
2 » ..	—	—	33 4/5	9 » ..	—	2	32
3 » ..	—	—	50 3/4	10 » ..	—	2	49
4 » .	—	1	7	50 » ..	1	6	5
5 » ..	—	1	24	100 » ..	3	4	10
6 » ..	—	1	41	500 » ..	17	4	50
7 » ..	—	1	58	1 liter ..	35	1	34

MEASURES OF MASS.

Kilograms (kgm.), grams (gm.), centigrams (cgm.), Milligrams (mgm.) and Imperial Pounds (lb.), Ounces (oz.) and Grains (gr).

Metric	Lb.	Oz.	Gr.	Metric.	Lb.	Oz.	Gr.
1 mgm.	—	—	1/64	1 gm.	—	—	15 1/2
2 »	—	—	1/33	2 »	—	—	30 7/8
2 »	—	—	1/21	3 »	—	—	46 1/4
4 »	—	—	1/16	4 »	—	—	61 3/4
5 »	—	—	1/13	5 »	—	—	77 1/6
6.5 »	—	—	1/10	7.5 »	—	—	115 3/1
8 »	—	—	1/8	10 »	—	—	154 1/3
1 cgm.	—	—	1/6	15 »	—	—	231 1/2
2 »	—	—	1/3	20 »	—	—	308 3/5
3 »	—	—	1/2	30 »	—	1	25 1/2
5 »	—	—	3/4	40 »	—	1	179 4/5
6.5 »	—	—	1	50 »	—	1	334
10 »	—	—	1 1/2	75 »	—	2	282 1/2
15 »	—	—	2 1/4	100 »	—	3	230 3/4
20 »	—	—	3	150 »	—	5	127 1/2
26 »	—	—	4	250 »	—	8	835
30 »	—	—	4 1/2	500 »	1	1	278
40 »	—	—	6 1/4	750 »	1	10	200
50 »	—	—	7 3/4	1 kgm.	2	3	120
75 »	—	—	11 1/2	—	—	—	—

APPENDIX II.

METEOROLOGICAL OBSERVATIONS IN 1904.

The year 1904 represents one of the normal weathers in Portugal. The object of the following tables is to enable the reader to see the monthly march of weather, and to compare more fully one station with another.

The mean temperature and the mean relative humidity of Montalegre, Moncorvo, Guarda, Vila Fernando, and Evora, are from two observations a day, and of the remaining stations they are from three observations.

I. NORTH ATLANTIC REGION. I., 1. MONTALEGRE.

Months.	Means of pressure 600 +	Direction of winds.															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	77,23	6	0	2	5	14	0	0	0	2	0	2	5	14	1	10	1
Feb. ...	72,98	10	0	2	1	3	0	1	0	3	0	1	12	13	0	11	1
March..	72,13	7	0	7	3	14	0	3	1	4	1	3	0	6	1	12	0
April...	76,30	9	0	8	4	12	0	4	1	5	0	0	5	10	0	2	0
May....	6,87	6	0	2	2	8	0	5	1	11	2	1	2	14	1	4	3
June....	77,08	6	0	0	2	8	0	6	0	10	0	4	1	18	1	3	1
July....	77,89	2	0	1	0	4	0	3	0	12	0	7	3	27	0	3	0
August.	78,84	7	0	1	0	9	1	1	0	13	0	1	1	23	0	3	2
Sept....	76,71	4	0	1	2	9	1	6	6	3	0	3	1	17	2	3	2
Oct.....	77,59	4	0	3	1	14	0	12	5	8	0	3	2	5	1	3	1
Nov....	77,61	5	0	3	0	29	1	10	1	1	0	0	1	3	0	2	4
Dec.....	77,39	2	0	1	2	16	1	7	0	3	0	5	0	13	1	7	4
Year....	76,56	68	0	31	22	140	4	58	15	75	3	30	33	163	8	63	19

I., 2. OPORTO (SERRA DO PILAR

Months.	Means of pressure 700 +	Direction of winds																
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.	C
January.	59,47	8	1	1	5	11	7	8	1	13	7	5	3	4	4	1	4	
Feb.....	54,76	12	4	1	2	1	5	2	1	8	13	10	5	3	1	11	3	
March..	52,64	9	5	1	1	8	11	5	0	14	0	0	1	0	8	8	5	1
April ..	55,66	17	7	3	2	5	2	3	0	1	7	1	1	2	5	1'	12	1
May....	56,10	5	0	0	1	1	3	1	0	7	3	6	3	6	14	15	8	2
June....	56.55	2	0	0	0	1	0	1	0	3	7	2	9	9	22	19	3	1
July. ...	56,56	4	0	0	1	1	0	1	0	4	2	2	2	13	10	24	8	1
August.	56,21	8	0	0	1	3	2	2	2	4	3	6	1	7	21	17	3	1
Sept....	54,73	5	0	1	0	4	8	4	1	8	4	3	3	8	8	14	4	1
Oct.....	55,19	5	0	3	6	15	19	5	3	5	3	1	2	8	3	5	0	1
Nov....	57,28	4	2	3	7	23	21	7	0	0	0	2	1	3	4	5	2	
Dec.....	58,03	1	0	1	3	12	21	4	0	17	2	0	6	4	8	8	1	
Year. ..	56,09	80	19	13	29	88	99	43	8	84	51	38	37	6	117	139	53	13

t., 41°.49′. Alt., 1.027 m. Dist. from the Sea, 90 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days.		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
–	–	81,0	101,0	17	2	2,59	6,75	−1,57	13,0	− 5,7
–	–	83,0	227,6	22	7	3,13	6,83	−0,57	12,1	− 5,0
–	–	69,6	95,0	9	6	4,23	9,36	−0,89	17,9	− 8,0
–	–	54,4	21,0	7	0	9,38	15,44	3,32	26,2	− 1,1
–	–	55,2	20,4	10	0	13,16	19.17	7,14	29,1	0,2
–	–	45,5	21,4	3	0	16,52	23,73	9.31	29,8	4,6
–	–	42.7	9.4	2	0	17,07	24,67	9,47	31,2	5,8
–	–	41,7	5,4	2	0	18,47	25,92	11,02	33,6	5,0
–	–	58,3	77,8	10	0	14.42	20,85	8,00	27 9	3.6
–	–	62,6	31,2	7	0	12,99	18,84	7,13	26,0	2,0
–	–	69,6	14,0	9	2	8,07	14.49	1,65	18,8	− 5,7
–	–	81,0	127,4	18	0	5,65	9.59	1,71	19,0	− 4,6
–	–	62,0	751,6	116	17	10,47	16,30	4,64	33,6	− 8,0

t., 41°.9′. Alt., 100 m. Dist. from the Sea, 5 km.

Velocity.	Evaporation in mm. (mean)	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
5,41	3,94	81,6	222,6	20	0	8,20	11 87	5,25	15,0	0,5
1,50	4,72	81,1	221,8	22	0	9,54	12,29	7.11	15,0	2,0
7,15	5,86	73,7	81,3	15	0	9,88	13,44	6 67	17,7	1,3
8,64	9,33	70,3	37,0	6	0	14,42	18.83	10,43	26,2	6,0
4,24	7,52	76,4	30,0	7	0	16,25	20,09	12,56	31,2	7,0
1,89	7,07	76,3	27,6	4	0	18,13	21,69	14,98	29,0	11,2
2,64	7,23	77,1	11,7	6	0	18 95	22,33	15,27	26,5	11,5
2,50	8,85	73,6	15,6	3	0	19171	24,18	15,38	28,8	12,2
1,01	6,50	77,6	69,2	15	0	17,31	21,26	13,98	27,7	8,7
4,02	9,44	73,0	23,1	7	0	16,69	21,93	12,94	27,0	8,6
2,61	5,82	72.7	8 1,8	14	0	11,42	15,0	7,91	22,0	0,5
7,94	5,67	81,9	144.5	20	0	10,85	14,09	8,40	16,5	1,6
4,96	6 83	76,3	966,2	139	0	14,30	18,17	10,91	31.2	0,5

I., 3. COIMBRA.

Months.	Means of pressure 700+	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.	[illegible]
January.	754,62	15	8	5	29	22	12	17	60	15	12	11	7	16	18	55	30	
Feb....	50,39	2	3	1	0	6	5	9	28	20	28	31	24	14	31	61	45	
March..	47,5c	9	8	12	14	4	25	8	31	13	10	1	0	1	27	95	67	1
April...	50,41	5	11	13	14	7	14	1	11	4	5	1	7	8	42	132	37	
May....	51,01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
June....	50,50	8	2	0	2	1	3	1	6	4	3	3	4	4	87	1[illegible]3	56	
July....	51,58	11	2	0	0	0	0	4	1	1	1	3	4	3	110	143	62	1
August	51.32	9	0	1	5	3	2	9	11	11	5	5	3	8	109	115	40	
Sept....	49,85	4	0	1	5	4	12	19	19	13	6	1	6	9	82	115	20	
Oct....	50,09	3	3	5	29	12	36	53	55	12	7	2	1	3	18	67	18	
Nov....	52,08	8	5	4	20	18	76	43	29	5	3	0	4	1	8	28	25	
Dec....	53,40	3	2	0	10	9	64	30	17	23	19	5	8	3	50	35	10	
Year....	751,06	77	44	42	128	8	249	194	298	121	99	63	68	70	582	979	410	6

II. LUSITANIAN REGION. II., 1. GUARDA.

Months.	Means of pressure 700+	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.	C.
January.	77,04	1	0	1	7	1	0	0	0	6	2	3	3	6	0	25	0	[illegible]
Feb....	72,94	0	0	0	2	0	0	1	0	6	0	7	12	2	0	27	0	[illegible]
March..	70,96	0	1	3	3	0	2	3	1	11	0	0	1	2	1	29	0	[illegible]
April...	74,94	2	0	3	11	0	0	0	0	7	0	2	0	1	1	24	0	[illegible]
May....	76,19	0	0	0	4	0	0	3	0	22	0	2	2	2	1	19	0	[illegible]
June....	76,34	0	0	1	1	1	0	2	1	11	0	1	0	5	3	18	0	[illegible]
July....	77,14	0	0	0	2	2	1	7	0	1[illegible]	0	2	0	3	0	28	0	[illegible]
August	77,50	0	0	0	3	3	2	5	2	17	0	2	1	0	0	23	0	[illegible]
Sept....	75.34	1	0	3	4	1	0	6	4	9	0	1	3	2	1	21	0	[illegible]
Oct....	76,26	0	0	0	12	8	0	8	0	22	0	0	0	1	0	7	0	4
Nov....	76,49	0	0	1	7	3	1	7	4	12	1	1	0	0	3	17	0	[illegible]
Dec....	76,89	0	0	0	3	1	2	6	5	11	0	2	5	6	5	12	0	4
Year....	75,67	4	1	12	59	20	8	48	17	147	3	23	27	30	15	250		6[illegible]

t., 40°.12'. Alt., 140 m. Dist. from the Sea, 38.km5.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
1,5	50,9	82,9	173,0	14	0	8,87	11,59	4,90	14.2	1,2
5,8	65,7	85.4	218,3	23	0	10,09	12'56	6,50	15,4	2,2
5,4	111,5	77,3	89,5	17	0	10,64	14,01	6,20	18,2	0,7
3,5	203,8	67,2	31,8	4	0	15,78	20,93	9,54	29,5	5,2
—	223,4	72,5	21,7	9	0	18,13	23,69	11,80	35 8	5,7
1,7	226,7	75,8	18,6	5	0	19,85	25,55	14,00	33,1	11,5
1,9	279,5	73,2	1,2	1	0	20,98	26,59	14,64	31,9	11,4
1,6	289,0	72,0	3,2	1	0	22,07	28,43	15,98	35,0	12,7
0,4	164,7	79,9	74,7	12	0	18,50	23,33	13.27	30,1	8,7
2,8	172,4	69,5	16,9	9	0	18,82	23,52	13,45	30,1	9,5
2,7	90,6	75,1	152,0	11	0	13,12	16,60	8,75	23,4	0,5
4,3	65,9	83,1	148,3	18	0	11,72	14.20	8,38	16,6	3,2
2,9	1953,1	76,2	949,2	124	0	15,71	20,09	10,61	35,8	0,5

t., 40°.32'. Alt., 1.037 m. Dist. from the Sea, 120 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
3,53	—	84,0	96.2	9	6	2,99	5,68	0,30	9.2	—4,7
4,13	45,4	83,7	190,4	18	5	4,00	6,56	1,44	10,2	—2 9
9,40	56,5	75,9	144,5	11	11	4,42	7,37	1,46	15,1	—5,2
5,78	156,6	50,8	23,6	4	0	10,79	15,32	6,26	23,1	0,6
3,73	231,3	52,3	23,7	3	0	14.57	19,22	9,92	26 2	1,0
1,54	223,8	52,7	22,7	4	0	17,14	22,84	11,44	30,7	4.7
4,00	277,5	40,7	0,0	0	0	18,62	24,71	12 52	29,7	8,0
4,19	299,1	39,5	0,0	0	0	20,19	25,73	14,66	32,1	8,3
4,09	161,5	59,[illegible]	36,6	7	0	15. 3	19,41	10,81	28,7	4.7
4,72	150,7	59,8	18,0	5	0	13,57	18,03	9.11	25,7	3,1
6,05	60,0	78,2	34,3	4	6	6,64	9.61	3,68	16,0	—3,6
3,33	47,8	81,2	95,0	14	2	5,88	8,15	3,62	13,3	— 2,1
1,21	1712 2	63,2	685,0	79	30	11,16	15,22	7,10	32,1	—5,2

II, 2. SERRA DA ESTRELA (POIO NEGR(

Months.	Means of pressure. 600+	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	48,23	1	0	2	3	6	7	7	1	1	1	4	3	5	33	16	0
Feb. ...	44,05	2	1	0	0	3	1	4	2	2	1	5	8	20	22	14	1
March..	42,65	5	0	4	1	10	6	15	1	6	1	6	1	6	16	12	2
April...	47,15	3	3	4	5	16	14	10	2	3	0	1	1	2	10	7	5
May....	48,62	1	0	0	0	6	10	16	11	1	1	3	0	9	13	16	6
June....	48,77	1	0	2	1	9	5	17	1	0	1	3	2	15	17	13	2
July. ...	49,86	0	0	0	0	9	11	19	2	0	0	3	4	15	13	13	2
August.	50,29	0	0	1	1	10	3	22	4	1	0	1	2	11	22	13	2
Sept....	47,72	1	0	0	0	6	20	8	2	0	1	0	1	6	33	12	0
Oct. ...	48,61	1	0	2	1	0	32	28	1	0	0	0	2	4	7	4	1
Nov ...	47,93	2	0	2	0	9	26	17	2	1	0	1	1	5	13	7	0
Dec	48,18	0	0	0	1	5	22	12	3	0	0	1	5	3	37	3	1
Year....	47,67	17	4	17	13	98	157	175	32	15	6	28	30	102	236	130	22

II., 3. SAN FIEL.

Months.	Means of pressure. 700+	Direction of winds. N.	NNE.	NE	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	22,94	14	7	4	11	1	0	1	0	4	2	8	14	2	3	12	9
Feb.....	18,84	6	2	2	6	2	1	1	0	1	4	13	23	6	4	11	5
March .	16,36	22	7	5	8	6	0	0	0	2	4	8	7	4	3	8	7
April...	19,28	18	8	2	17	8	1	1	0	1	1	6	5	5	4	5	7
May....	20,14	10	8	4	8	11	4	3	2	4	1	8	10	8	1	7	3
June....	19,21	12	1	1	8	4	5	0	2	6	1	8	13	9	8	8	1
July. ...	20,08	1	1	4	4	3	3	5	0	7	9	6	11	20	2	6	1
August.	20,30	10	8	11	5	0	0	1	4	4	9	12	5	5	7	10	1
Sept ...	18,92	3	5	12	15	8	2	1	2	1	0	2	6	10	3	6	8
Oct.....	20,14	9	9	13	11	2)	1	1	1	3	2	4	2	4	0	2	2
Nov....	21,28	6	10	19	16	14	3	1	4	1	2	3	2	0	2	4	6
Dec.....	21 59	3	4	7	12	19	2	2	3	1	2	5	10	9	1	4	8
Year ..	19,92	114	70	81	121	105	22	17	18	35	37	83	108	82	38	83	58

t. 40°.25′. Alt. 1.386 m. Dist. from the Sea, 102 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain.		Snow.	Temperature				
			Total in mm.	N.° of days.		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
8,75	—	85,3	654,3	17	5	1,11	3,50	—1,28	8,4	— 6,1
9,59	—	87,1	755,7	21	6	1,32	3.81	—1,17	8.3	— 4.6
8,31	—	81,6	46,0	20	12	1,65	4,17	—0.95	12,7	— 8,0
5,79	—	60,4	29,7	8	4	7,85	11,55	4,30	19.5	— 2,8
9,39	339,2	62,4	35,2	8	0	11,58	15,48	7,70	22,3	0 0
5,36	385,2	52,7	91,8	6	0	15,39	19.26	11,70	26,7	2,3
6,51	—	46.6	33,3	1	0	16,60	20,52	12,68	27,1	6,0
4,77	—	48,5	0,3	1	0	17,56	21,52	13,80	27,8	6,2
9,12	285,3	65,3	123,4	9	0	12,49	15.73	9,29	26,0	2,4
14,15	188,6	68,0	87,3	12	0	10.97	14.03	8,00	21,4	2,0
16,20	—	77.5	194,7	12	5	4.91	7.21	2.56	14,8	— 6,2
28,01	—	81,2	722,2	20	4	4,32	6,78	1,78	12,7	— 5,0
19,66	—	68,0	2773,9	135	36	8,81	11.96	5,70	27,8	— 8,0

at. 40°.22′. Alt. 516 m. Dist. from the Sea, 125 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days.		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
16,61	125,9	69,7	67,8	8	1	6.92	10,02	4,14	13,5	1,6
21,89	130,0	72,5	165,9	13	0	7.76	11,04	5,00	14.4	1,8
15,67	174.7	63,5	102,6	7	3	8.71	12,39	5,35	19,4	0,0
17,04	355.2	42.6	7.6	2	0	15,37	20,07	11,03	26.4	5,5
11,58	396,5	45.9	17,3	2	0	18,99	24,13	14.07	30.9	7,2
10,88	—	41,7	10.4	1	0	22.17	27.95	16.67	34.9	9.5
10,30	495,6	38,0	0,0	0	0	23,58	29,57	17,20	35,0	12.5
10,86	523,4	33,8	0,0	0	0	25,10	30,72	19.85	36.7	13,9
10.15	328,3	50,6	41.2	9	0	19.60	24.22	15,48	33.5	9.7
10,87	254,3	60.5	45,1	9	1	17,83	21 86	14,01	28,7	9.8
14,27	148,1	76,4	119,6	6	0	11.01	14,23	8,16	20,8	2,0
16,40	102.0	82,0	85,7	12	0	9.64	12,34	6,92	18,0	2,2
13,88	—	56,5	663,2	69	5	15,56	19,88	11.49	36,7	0,0

II., 4. LISBON.

Months.	Means of pressure 700 +	Direction of winds.															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	59,59	9	19	5	1	0	0	0	1	2	9	13	4	5	6	3	15
Feb.....	55,86	6	4	0	4	0	1	0	0	1	13	24	3	2	7	6	15
March..	52,16	15	11	9	3	2	2	2	0	4	6	2	4	4	6	7	15
April...	54,68	22	12	14	2	1	1	1	0	3	1	3	5	0	6	5	14
May....	55,55	24	5	6	2	1	1	0	1	4	6	6	7	2	4	5	19
June....	55,11	6	3	0	0	0	2	1	4	9	4	9	10	3	19	6	14
July....	56,21	2	1	0	0	0	0	0	2	3	7	7	2	3	19	25	22
August.	55.87	9	3	1	2	0	0	1	3	2	7	7	1	2	10	29	16
Sept....	54,52	9	2	2	1	1	2	2	3	3	8	9	2	7	1	18	18
Oct.....	54.52	15	18	8	1	4	4	6	0	7	7	2	6	1	1	7	6
Nov	56,48	18	25	7	3	0	6	1	2	2	4	1	0	2	4	7	8
Dec	58,48	8	18	7	2	4	1	0	0	1	11	5	10	6	5	7	3
Year....	55,75	143	121	59	21	13	20	14	16	41	83	88	54	37	92	125	165

III. MEDITERRANEAN REGION. III., 1. LAGOS.

Months	Means of pressure 700 +	Direction of winds.															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January	66,99	44	0	13	0	4	0	0	0	0	0	1	0	7	0	23	0
Feb.....	63,93	26	0	6	0	5	0	1	0	1	0	0	0	12	0	36	0
March..	59,33	35	0	11	3	5	0	10	0	1	0	4	0	8	0	16	0
April...	61.47	28	0	2	2	15	0	5	0	2	0	5	0	4	1	26	0
May....	62 36	34	0	2	1	10	1	14	0	5	0	6	0	5	0	15	0
June. ..	61,84	46	0	0	0	6	0	11	0	1	0	9	0	5	1	11	0
July....	62 63	68	0	2	0	6	0	9	0	1	0	2	0	1	0	4	0
August.	62,19	57	0	0	1	5	0	9	0	2	0	9	0	4	0	6	0
Sept ...	60,77	41	0	2	0	4	0	7	0	1	0	21	0	4	0	10	0
Oct.....	61,12	17	0	3	1	24	0	21	0	6	1	8	0	5	0	7	0
Nov	63,19	19	0	11	0	14	0	22	0	3	0	9	1	3	0	8	0
Dec	60,92	31	0	4	0	16	0	11	0	2	0	1	1	8	0	19	0
Year....	62,61	446	0	56	8	114	1	120	0	25	1	75	2	66	2	181	0

...t., 38.°43′. Alt., 95 m. Dist. from the Sea, 12 km

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
17,02	23,4	79,6	53,9	15	0	10,43	12,94	8,40	15.4	5.4
23,20	28,1	81,3	133,7	19	0	11,25	13,37	9,50	15,0	6,5
20,69	58,1	70,8	69,8	16	0	11,28	14.44	8,86	18.8	5,0
20,82	98,6	58.1	20,9	5	0	15,47	20,08	11,74	27,6	9.2
18,59	108,0	61,8	11,0	4	0	17.54	22,11	13.92	32.6	8.9
16.97	115,7	66,5	9,5	1	0	19,23	23,35	15,91	33,5	13,5
17,75	150.7	62,1	0,0	0	0	20,72	25,34	17,15	29.5	15,0
19,03	148,8	58,1	0,0	0	0	22,03	26,64	18,56	32,8	16,5
18,07	85,9	66.8	33,0	8	0	18,88	22,69	16,14	29.2	13,8
15,40	80,3	61,8	40.9	8	0	18,85	22.91	15,55	30.0	11,0
14,21	39.2	71,9	107,8	15	0	13.56	16.87	10 97	23.0	5,6
16,84	28,6	80 0	68.7	19	0	12,50	14.78	10,64	16,8	5,3
18,22	965,4	68,5	549,2	110	0	15,98	19,63	13,11	53,5	5.0

...at., 37.°6′ Alt., 13 m. Dist. from the Sea, 0km,06.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
—	—	67,6	65,4	4	0	10.98	15,89	6.23	20.7	2.2
—	—	71,1	38,8	7	0	12,24	16,16	8,22	19.2	4.2
—	—	63,4	78,0	12	0	12,62	17,60	8,21	23.2	3.6
—	—	52,6	0.0	0	0	16.20	21.79	10,83	26.2	8.6
—	—	56,0	8,0	1	0	18,51	23,95	13,53	30.2	10.0
—	—	56,7	5,8	1	0	19,54	25.95	15,42	34.2	12.0
—	—	51,9	0,0	0	0	21.33	28,80	16,51	33,0	13.2
—	—	51.2	0,0	0	0	23,48	29 74	17,50	3[illegible],0	15.2
—	—	58,3	41,3	7	0	20,78	26.77	15,39	33.0	12.2
—	—	63,7	9,8	4	0	19 77	24,37	15,54	31.2	10,8
—	—	69,1	103,6	11	0	15,83	20,06	11.81	23.1	4.8
—	—	76,2	96,0	10	0	13.99	17.42	10.96	19.4	4.0
—	—	61.5	446,7	57	0	17.11	22,37	12.51	35.0	2,2

III., 2. FARO.

Months	Means of pressure 700 +	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	66,78	17	2	2	4	6	2	3	3	0	3	7	9	7	3	17	7
Feb. . . .	63,83	6	1	2	0	6	3	1	1	2	7	14	9	5	7	13	9
March . .	59,38	6	1	1	1	5	8	7	0	3	4	10	7	10	9	13	8
April. . .	61,23	5	0	0	1	7	10	9	0	2	7	13	5	4	4	9	9
May. . . .	62,45	1	0	0	0	13	7	9	2	5	5	15	4	5	4	11	8
June. . . .	61,78	0	1	0	0	5	5	2	3	7	8	21	11	9	4	6	7
July. . . .	62,42	1	0	0	0	4	2	5	4	3	14	20	4	8	2	16	5
August	62,53	1	0	1	1	11	3	8	2	5	8	24	9	3	5	9	2
Sept . . .	61,13	0	1	1	1	5	2	9	4	2	8	20	4	11	3	12	6
Oct.	61,75	0	0	7	5	16	21	5	3	3	7	8	5	4	3	2	3
Nov. . . .	63,53	5	6	2	1	23	10	13	3	1	2	2	1	1	9	6	4
Dec. . . .	66,29	1	3	1	0	17	11	6	1	0	2	9	11	9	11	10	1
Year. . . .	62,76	43	15	17	14	118	84	77	26	33	75	163	79	76	64	124	69

IV. NORTH CONTINENTAL REGION. IV., 1. MONCORVO.

Months.	Means of pressure 700 +	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	29,94	2	1	3	4	15	0	0	0	1	3	3	2	6	1	1	1
Feb. . . .	25,13	2	3	4	4	1	0	1	0	5	5	8	6	2	6	5	2
March . .	[illegible]	4	2	6	9	10	2	0	1	2	1	4	2	0	0	4	3
April. .	26,72	2	3	7	6	15	0	1	0	1	0	0	0	3	0	3	1
May. . . .	27,09	3	2	9	2	1	0	1	1	6	2	7	3	4	4	3	2
June. . . .	26,17	4	2	3	5	7	0	0	1	0	1	3	3	3	3	4	1
July. . . .	27,01	1	1	4	8	6	0	0	0	0	1	0	1	13	4	4	3
August	27,29	1	3	3	7	4	0	1	0	1	0	4	2	2	0	3	1
Sept. . .	26,06	0	1	3	0	2	1	1	0	5	0	4	0	3	3	8	3
Oct. . . .	27,31	1	2	13	1	0	0	1	0	0	0	4	0	4	0	2	0
Nov. . .	28,75	1	1	10	0	0	0	4	0	0	0	3	0	2	0	3	0
Dec. . . .	29,40	2	0	15	2	1	0	2	0	0	0	4	2	5	0	6	0
Year. . . .	27,04	23	21	70	48	62	3	12	3	21	13	44	21	47	21	46	17

.., 36°.57′. Alt, 14 m. Dist. from the Sea, 0.km5.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
—	—	74,5	68,8	5	—	11,09	—	—	—	—
—	—	76,2	31,8	14	—	12,27	—	—	—	—
—	—	70,4	53,9	15	—	12,45	—	—	—	—
—	—	72,7	12,2	3	—	16,65	—	—	—	—
—	—	71,7	8,9	3	—	19,63	—	—	—	—
—	—	71,0	16,0	2	—	21,22	—	—	—	—
—	—	69,5	0,0	0	—	23,59	—	—	—	—
—	—	68,2	0,0	0	—	23,82	—	—	—	—
—	—	67,1	62,3	7	—	21,32	—	—	—	—
—	—	68,0	18,1	1	—	20,40	—	—	—	—
—	—	77,1	30,9	10	—	15,65	—	—	—	—
—	—	79,3	82,2	8	—	13,77	—	—	—	—
—	1953,1	72,1	391,1	68	—	17,65	—	—	—	—

.., 41°.10′. Alt., 415 m. Dist. from the Sea, 170 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
—	—	92,4	61,8	12	0	5,52	7,06	3,97	10,4	2,0
—	—	83,9	124,6	12	0	8,13	9,56	6,70	12,1	4,5
—	—	78,3	59,4	10	1	9,11	11,20	7,03	15,0	3,0
—	—	59,6	18,8	3	0	15,49	18,43	12,54	22,2	9,7
—	—	59,9	19,2	2	0	20,59	23,55	17,63	28,6	13,0
—	—	51,8	20,0	4	0	23,95	27,17	20,73	31,3	16,0
—	—	45,7	0,0	0	0	25,99	29,33	22,66	33,0	19,4
—	—	42,9	0,0	0	0	27,09	29,94	24,23	33,8	19,6
—	—	58,6	19,6	4	0	21,56	24,01	19,11	29,3	14,4
—	—	65,0	18,2	5	0	17,72	21,26	14,18	24,2	11,9
—	—	79,2	30,6	5	1	9,84	13,10	6,59	18,9	1,0
—	—	91,7	49,8	8	0	8,02	10,12	5,92	15,8	0,5
—	—	67,4	422,0	65	2	16,08	18,73	13,44	33,8	0,5

V. SOUTH CONTINENTAL REGION. V., 1. CAMPO MAIOR.

Months.	Means of pressure 700 +	Direction of winds.															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	41,14	21	2	6	0	2	1	1	0	0	2	11	5	12	0	12	2
Feb. ...	37,88	13	0	1	0	1	0	1	0	2	3	22	2	15	1	20	1
March..	34,38	18	1	5	0	11	0	0	0	0	3	10	1	14	0	17	1
April...	36,84	24	0	9	1	14	0	2	0	1	2	7	1	12	0	6	2
May....	37,88	3	c	3	0	11	5	4	0	3	3	8	5	23	2	20	0
June....	37,03	6	0	1	0	1	0	0	0	1	2	10	4	39	3	11	1
July....	37,81	1	0	1	0	0	0	0	0	2	0	6	4	36	3	22	6
August.	38,27	2	0	5	0	5	0	2	1	2	4	15	1	34	1	15	2
Sept....	36,70	5	0	3	0	7	3	3	0	5	1	14	3	18	6	16	4
Oct.....	37,49	13	1	11	1	22	2	5	6	4	3	7	0	4	3	5	1
Nov. ...	38,93	17	0	5	0	21	8	6	0	4	2	3	2	5	3	10	0
Dec.....	40,75	7	0	0	0	20	2	1	0	0	0	11	2	18	8	7	1
Year....	37.92	130	4	58	2	118	21	25	7	24	25	124	30	230	30	161	21

V., 2. VILA FERNANDO.

Months.	Means of pressure 700 +	Direction of winds															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	34,38	2	0	3	0	4	0	0	0	4	0	2	0	2	1	2	0
Feb.....	30,15	4	0	2	0	0	0	0	0	3	0	7	1	3	3	5	0
March..	26,79	1	0	2	0	10	0	0	0	2	0	4	0	1	0	10	0
April ..	29,66	7	0	1	0	12	0	0	0	2	0	1	0	0	0	3	0
May....	30,69	0	0	0	0	5	0	0	0	1	0	3	0	1	0	9	0
June.. ..	30,02	1	0	0	0	0	0	0	0	1	0	3	0	7	0	10	0
July. ..	31,25	2	0	0	0	2	0	0	0	4	0	0	0	7	0	11	0
August	31,32	0	0	0	0	3	0	0	0	2	0	1	0	5	0	7	0
Sept....	29,88	7	0	0	0	2	0	0	0	6	0	3	0	0	0	8	0
Oct.....	30,73	2	0	0	0	19	0	0	0	4	0	1	0	0	0	0	0
Nov...	32,05	2	0	0	0	16	0	0	0	1	0	1	0	1	0	6	0
Dec.....	33,73	1	0	0	0	16	0	0	0	3	0	0	0	4	0	10	0
Year. ..	30,89	32	0	8	0	89	0	0	0	33	0	23	1	31	4	81	0

t., 39°.2′. Alt., 288 m. Dist. from the Sea, 160 km.

…elocity.	Evaporation in mm. (mean)	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
,04	79,2	78,2	82,2	7	0	7,56	12 43	3,55	16,6	1,0
,41	91,8	7 ,9	115,8	13	0	9,08	13,54	5,23	17,9	1,8
,83	157,1	68,8	118,7	11	0	9,97	15,18	5,35	21,6	1,0
,53	281,5	47,3	19,5	3	0	16,19	22,82	6,76	28,9	5,0
,48	282,4	46,7	12,5	3	0	19,89	27,56	12,35	33,7	5,7
,75	362,3	44,7	18,0	2	0	22,27	30,41	14,24	38,4	10,6
,03	401,8	39,5	0,0	0	0	24,01	33,01	15,08	38,7	12,4
,04	349,2	39,8	0,0	0	0	24,07	33,73	16,60	39,8	13,2
,55	211,9	54,7	37,0	4	0	20,22	27,69	13,51	37,0	9,0
,06	200,1	51,1	31,5	5	0	18,00	25,36	13,40	33,9	10,0
,72	106,2	71,8	66,3	6	0	11,95	16,81	8,20	23,0	1,5
,98	88,8	81,2	55,5	7	0	10,18	14,48	6,72	17,3	2,8
,62	2612,3	58.5	557,0	61	0	16,27	22,75	10,33	39,8	1,0

t., 38°.58′. Alt., 375 m. Dist. from the Sea, 148 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days.		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
-	–	79,8	65,8	3	0	6,84	12,69	0,98	16,2	— 2,9
-.	–	79,7	167,8	10	0	7,43	14,13	1,72	18,0	— 1,0
-	–	71,7	105,6	7	0	9,05	15,94	2,16	23,1	— 3,0
-	–	50,6	35,3	3	0	15,19	23,57	6,80	31,1	2,0
-	–	45,5	8,4	1	0	19,15	28,72	9,58	37.4	4,5
-	–	45,2	42,8	3	0	22,73	33,75	11,72	41,1	7.0
-	–	35,0	0,0	0	0	23,87	35,21	12,53	41,6	5.0
-	–	34,4	0,0	0	0	25,29	35,91	14,68	42,6	5.0
-	–	55,1	47,8	3	0	19,52	27,52	11,52	37.1	7,0
-	–	53,3	54,1	5	0	19,23	26,66	11,80	31,2	6,1
-	–	68.6	74,3	5	0	12,23	17,93	6,54	23,7	— 0.0
-	–	82,5	23,4	3	0	10,35	15,08	5,62	18,4	— 0,0
-	–	58,5	625,3	43	0	15,95	23,93	7,97	42,6	— 3,0

V., 3. EVORA.

Months.	Means of pressure. 700+	Direction of winds. N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	37,59	14	3	2	1	1	1	1	0	7	6	2	1	1	2	12	8
Feb.	34,10	2	1	0	1	0	2	1	3	3	9	4	2	4	4	17	5
March..	30,41	19	3	1	0	0	1	3	0	10	2	0	0	0	3	10	10
April...	33,24	8	9	4	2	5	2	0	0	4	3	0	2	4	2	11	4
May....	34,31	8	3	1	0	3	3	0	3	3	4	0	1	1	2	11	17
June ...	33,88	12	0	0	1	1	0	0	5	12	6	4	1	3	1	11	3
July. ...	34,69	6	0	0	0	2	0	1	1	4	1	0	0	0	3	41	3
August.	34,45	4	1	1	0	2	1	1	1	7	4	2	0	0	1	25	12
Sept....	32,93	12	0	0	2	6	0	0	4	6	4	0	0	0	0	14	12
Oct. ...	33,79	8	3	3	1	11	11	4	3	9	0	0	0	0	1	5	3
Nov ...	34,95	8	4	9	4	2	8	8	5	0	0	0	1	1	0	7	2
Dec	36,86	4	3	0	3	2	13	1	0	4	1	3	3	9	6	4	6
Year....	37,38	105	30	21	15	35	42	20	25	69	40	15	11	23	25	168	85

V., 4. BEJA.

Months.	Means of pressure. 700+	Direction of winds. N.	NNE.	NE	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	42,78	2	5	9	2	6	1	1	4	2	2	7	7	10	10	18	6
Feb.....	39,62	4	3	0	0	1	0	1	0	2	3	2	11	24	11	17	8
March .	35.54	7	1	3	5	4	3	2	3	0	3	4	6	15	6	17	10
April...	37,83	5	5	10	11	6	3	3	2	4	0	4	4	6	9	16	2
May....	39,63	6	0	5	3	3	5	4	0	7	5	4	4	14	10	21	2
June...	38,55	3	1	0	4	0	2	3	1	6	2	7	5	24	7	18	7
July. ...	39,46	3	1	1	0	0	1	0	1	6	2	2	2	14	22	30	8
August.	39,34	2	1	5	2	1	0	1	5	6	2	2	3	17	16	25	5
Sept ...	37.72	3	4	2	3	3	0	1	5	3	1	8	7	12	17	14	7
Oct.....	38,18	1	4	6	5	11	10	7	2	9	6	5	5	3	7	9	3
Nov....	39,93	4	0	0	5	12	6	11	5	7	0	4	2	5	6	9	4
Dec.....	42,17	1	0	0	5	14	6	7	0	5	4	8	1	13	12	14	1
Year ..	39,18	41	25	50	45	61	37	41	28	57	30	57	57	157	133	208	63

at., 38.°35′. Alt., 315 m. Dist. from the Sea, 120 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
13,16	74,8	83,2	72,2	12	0	8 91	13,16	4,66	21,8	0,5
14,28	76,2	79,3	163,6	17	0	9,94	13,92	5,97	21,6	1,5
12,51	114,1	86,9	81,2	13	0	10,22	14,42	6,01	19,4	0,4
12,51	203,6	78,2	22,6	5	0	15,84	21,50	10,17	29,0	3,7
5,92	233,2	77,6	18,0	4	0	18,54	24,69	12.39	33,0	6,4
6,10	283,6	72,1	38,4	3	0	20,62	27,32	13,92	36,4	10,5
21,20	370,4	69,7	0,0	0	0	22.63	30,08	15,19	36,3	12,2
10,03	376,0	65,1	0,0	0	0	23,87	31,07	16,67	37,7	13,5
13,08	216,7	70,9	43,6	8	0	18,81	23,57	14,04	33,4	10,4
9,64	191,0	68,9	47,0	7	0	19,26	24,17	14,35	32,2	9,0
9,04	92,1	84,0	55,1	7	0	13,97	18,63	9 32	28,0	2,4
11,33	60,4	84,7	52,6	17	0	11,12	14.47	7,78	18,6	2,1
11,71	229',1	83,7	594,3	93	0	17,61	23,36	11,86	37,7	0,4

at., 38.°1′ Alt., 284 m. Dist. from the Sea, 75 km.

Velocity.	Evaporation in mm.	Relative humidity.	Rain. Total in mm.	Rain. N.° of days.	Snow.	Temperature. Mean.	Temperature. Means of maxima.	Temperature. Means of minima.	Temperature. Absolute maxima.	Temperature. Absolute minima.
11,92	61,0	80,8	73,2	16	0	8,25	11,72	5,19	15,0	1,6
16,30	76,4	80,9	116,4	17	0	9,46	13,05	6,55	17,0	3,0
13,07	102,4	72,8	98,1	16	0	9,84	14,34	6,10	20,0	0,7
12,81	202.9	57,4	24,0	6	0	15,29	21,28	10,25	28,5	6.4
12,40	258,2	51,7	20,2	3	0	18,39	25,52	12,25	32,6	5.7
12,85	279,0	53,2	26,2	3	0	20,21	27.48	14,24	36,7	11.2
13,08	349,8	46,4	0,0	0	0	22,04	30.36	14,74	34,7	11,7
12,61	340,5	56,8	0,0	0	0	23,34	1.28	16,55	36,0	12,6
12,12	199.7	60,3	89,3	9	0	18,84	25.39	13,59	22,9	9.0
9,97	187.6	59,4	48,9	7	0	18,68	24,37	14,13	30.5	9,1
10.31	73,2	76,5	72,2	12	0	12,68	16,82	9.31	22,9	2.6
12,34	33,2	85,0	66,9	18	0	10,65	14.03	7,76	16,4	2,2
12,48	2163,9	65 1	635,4	107	0	15,64	21,30	10,89	36,7	0,7

VI. THE INSULAR REGION. VI., 1. ANGRA DO HEROISMO.

Months.	Means of pressure 700 +	Direction of winds.															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	63,61	5	0	6	1	3	6	18	1	0	0	10	5	16	4	17	1
Feb. ...	62,04	10	0	6	0	2	0	4	0	4	1	12	3	14	3	25	3
March..	60,31	23	5	12	6	7	0	14	0	8	0	5	3	8	0	0	0
April...	66,46	10	0	2	7	8	8	21	0	4	0	4	1	10	1	9	0
May....	60,79	8	2	3	3	2	3	6	2	3	1	16	1	25	2	15	
June....	62,51	8	3	1	2	3	4	11	0	4	0	10	5	23	1	15	0
July....	61,86	22	0	15	0	0	0	8	0	2	0	5	6	15	1	17	1
August.	62,44	15	4	8	1	0	0	21	0	6	0	5	3	10	7	10	0
Sept....	63,26	14	1	18	2	4	5	5	0	2	0	5	1	12	7	11	2
Oct.....	59,69	20	7	20	1	3	6	11	0	8	0	0	0	10	0	7	0
Nov. ...	61,04	15	1	14	3	9	3	17	3	12	0	2	1	1	0	9	0
Dec.....	58,24	14	2	4	0	0	2	4	1	5	3	12	5	12	1	22	6
Year....	61,85	164	25	109	26	41	37	143	7	58	5	86	34	156	27	155	14

VI., 2. PONTA DELGADA.

Months.	Means of pressure 700 +	Direction of winds															
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
January.	68,28	4	1	4	4	6	1	7	8	1	3	18	55	4	4	1	3
Feb.....	66,13	8	8	3	0	1	1	2	1	4	4	12	13	8	5	2	8
March..	63,74	9	19	9	1	1	4	9	8	7	4	8	1	1	3	0	5
April.. .	69,58	3	5	21	12	1	1	5	10	6	0	2	1	0	2	2	10
May....	64,28	4	10	6	3	0	0	3	3	7	12	20	8	7	4	3	1
June....	65,48	2	11	16	2	3	5	1	2	2	5	15	9	11	4	1	0
July. ...	65,11	4	19	9	0	0	0	1	1	0	8	15	10	8	9	4	3
August.	65,51	8	15	5	4	0	1	2	12	4	2	13	6	6	2	4	5
Sept....	66,15	10	12	13	0	2	1	0	7	1	2	12	6	1	2	3	11
Oct.....	61,84	8	23	28	5	0	3	3	2	2	2	4	0	1	0	2	6
Nov....	63,85	5	10	23	3	2	11	10	6	9	2	1	1	0	0	1	1
Dec.....	62,70	4	7	0	0	0	6	2	3	4	7	21	6	8	9	6	3
Year. ..	65,22	69	140	137	34	16	34	45	63	47	51	141	76	55	44	29	56

Lat. 38°.39′. Alt. 44 m. Dist. from the Sea, 362 m.

Velocity.	Evaporation in mm.	Relative humidity.	Rain		Snow.	Temperature				
			Total in mm.	N.° of days		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
32,61	—	83,6	48,3	13	0	14,98	16,89	13,07	19.1	9,9
35,61	—	81,7	103,0	18	0	13,74	15,74	11,57	17.3	6.9
26,70	—	80,8	93,0	11	0	13.30	15,51	11,08	19,2	6,0
25,43	—	79,8	15,0	2	0	15,18	17.35	12,85	19,7	9,0
29,71	—	80,1	68,0	13	0	16,10	18,47	13,73	20,7	11.4
2[illegible],75	—	81,8	68,0	6	0	17,43	19.87	14,97	21,7	8,2
21,36	—	79,1	50,0	4	0	19,29	21,84	16,64	2[illegible].3	14.7
19,35	—	84,0	109,2	10	0	20,61	23,22	18,10	25,3	15,7
22,01	—	81,4	56,0	10	0	19,64	22,39	16,85	25,4	13,6
31,91	—	76.9	306,0	16	0	17,51	20,02	14,72	23,6	9,0
26,99	—	83,0	165,0	11	0	16,42	18,56	14,27	20,2	10,7
36,43	—	83,3	254,0	18	0	14,87	17,22	12,66	19,3	9.0
2[illegible],91	—	81,3	1335,5	132	0	16,59	18,92	14,21	25,4	6,0

Lat. 37°.45′. Alt. 17 m. Dist from the Sea, 30 m.

Velocity.	Evaporation in mm.	Relative humidity.	Rain.		Snow.	Temperature				
			Total in mm.	N.° of days.		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
20,53	106,4	78.4	13,8	10	0	15,19	17,24	13,25	19,0	9.4
21,72	102,9	76,7	46,7	17	0	14.11	16,64	11,77	18,2	7,4
19,08	123,3	72,1	49.0	16	0	13,46	15,89	11,04	19,1	7,8
15,87	112,4	73,6	15.3	11	0	15,31	17,89	12,82	20,4	11.0
20,29	103,5	76.5	89,3	16	0	16,15	18,63	13,67	20.7	10,9
19,53	86,0	80,8	63,6	13	0	17.83	20,12	15.58	23,4	13.6
14,70	114,9	72,3	29.4	12	0	19,46	22,01	17.03	24,9	14,4
13,88	99,2	78,0	98,8	16	0	20,76	23,65	18,12	26.2	16.2
13,02	121,0	72,1	37,9	9	0	19.76	22.53	17,03	24.8	14,2
21,08	122,2	77,7	170,8	25	0	17,74	20,26	15,30	23.9	10,0
21,33	96,4	81,2	77,9	17	0	16,88	18,95	15,00	20,9	12,6
23,91	98 9	80,4	112,0	23	0	15,61	17,77	13,53	19.7	10.3
18,75	1281,8	76,7	804.5	185	0	16,85	19.30	14.51	26,2	7,4

VI., 3. FUNCHAL

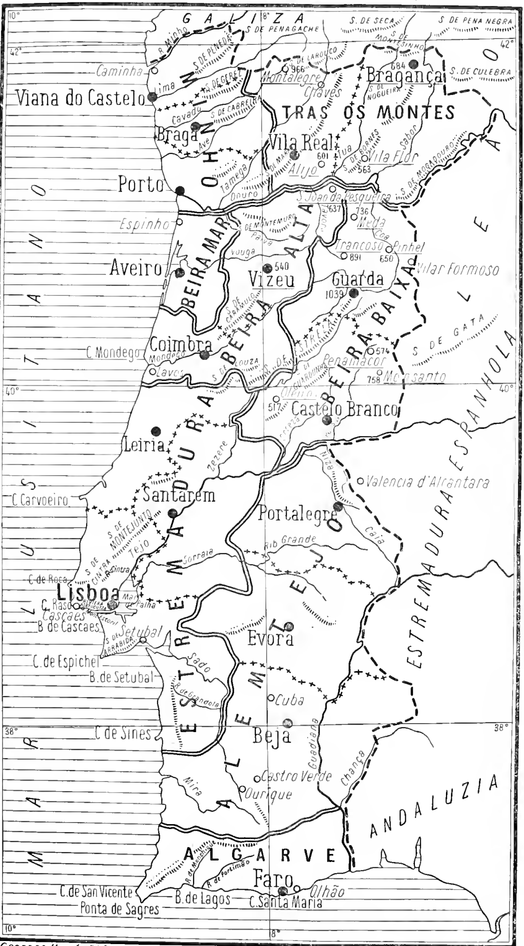
Months.	Means of pressure 700 +	Direction of winds.																
		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.	C.
January.	67,85	1	2	13	0	6	0	4	0	0	0	1	0	2	0	1	0	1
Feb.....	66,70	7	1	4	0	4	0	0	0	1	0	4	0	2	0	2	0	4
March..	61,31	8	1	10	1	2	0	0	0	2	0	1	1	1	0	3	1	0
April...	64,04	4	2	19	0	2	0	0	0	0	0	0	0	0	0	0	2	1
May....	63,51	5	2	12	0	3	0	0	0	0	0	4	0	0	0	5	0	0
June....	64,13	9	10	8	0	0	0	1	0	0	0	0	1	0	0	0	0	1
July....	64,03	1	1	17	2	1	0	0	0	0	0	2	0	0	0	1	0	6
August.	63,88	2	0	17	1	1	0	1	0	0	0	1	0	0	0	3	0	5
Sept....	63,45	8	1	10	0	2	0	0	0	0	0	0	0	0	0	3	3	3
Oct.....	59,16	8	1	7	0	0	1	1	0	3	2	3	1	2	0	0	0	1
Nov	61,91	0	1	9	1	2	0	1	0	2	0	7	0	1	0	5	0	1
Dec	65,10	1	1	5	0	3	0	5	1	0	0	6	0	0	0	6	2	1
Year....	63,76	54	23	131	5	26	1	13	1	8	2	29	3	8	0	29	8	24

t., 32°.38′. Alt., 25 m. Dist. from the Sea, 107 m.

Velocity.	Evaporation in mm. (mean)	Relative humidity.	Rain.		Snow.	Temperature.				
			Total in mm.	N.° of days		Mean.	Means of maxima.	Means of minima.	Absolute maxima.	Absolute minima.
—	107,0	62,4	27,3	5	0	14,62	18,10	9,36	19,8	8,0
—	100,0	60,7	65,5	9	0	14,65	17,93	9,34	19,3	4,5
—	125,7	57,1	100,1	11	0	14,45	17,46	9,09	22,6	6,7
—	116,5	60,0	4,3	1	0	16,12	18,89	10,98	20,8	8,9
—	101,1	64,3	4,2	5	0	17,44	20,19	12,29	22,9	9,8
—	101,3	65,0	0,0	1	0	19,18	21,64	14,52	23,5	12,3
—	107,5	66,3	8,4	2	0	21,41	24,14	16,51	26,4	14,2
—	137,2	62,1	3,0	3	0	22,76	25,75	1 ,27	27,0	15,8
—	135,0	60,2	12,1	4	0	21,69	24,81	16,20	26,3	13,4
—	104,0	68,9	156,1	19	0	19,38	22,62	14,17	24,4	11,6
—	99,6	67,3	232,6	12	0	17,42	20,76	12,03	22,8	9,1
—	95,5	66,0	118,6	9	0	16,00	19,26	10,66	21,8	8,4
—	1330,4	63,4	732,2	81	0	17,93	20,96	12,69	27,0	4,5

Map I. **PORTUGAL.**

PROVINCES AND DISTRICTS.



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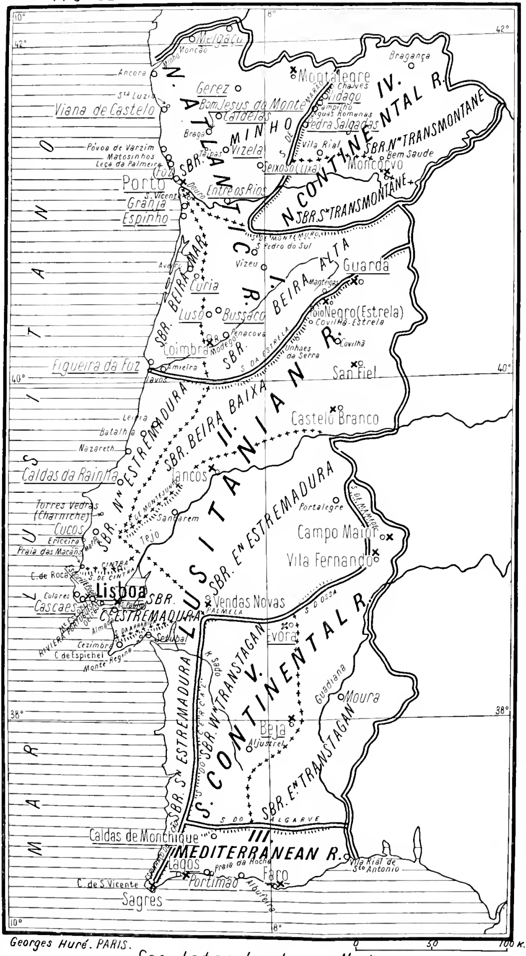
Map II. . PORTUGAL.

ITS CLIMATIC REGIONS AND SUBREGIONS.



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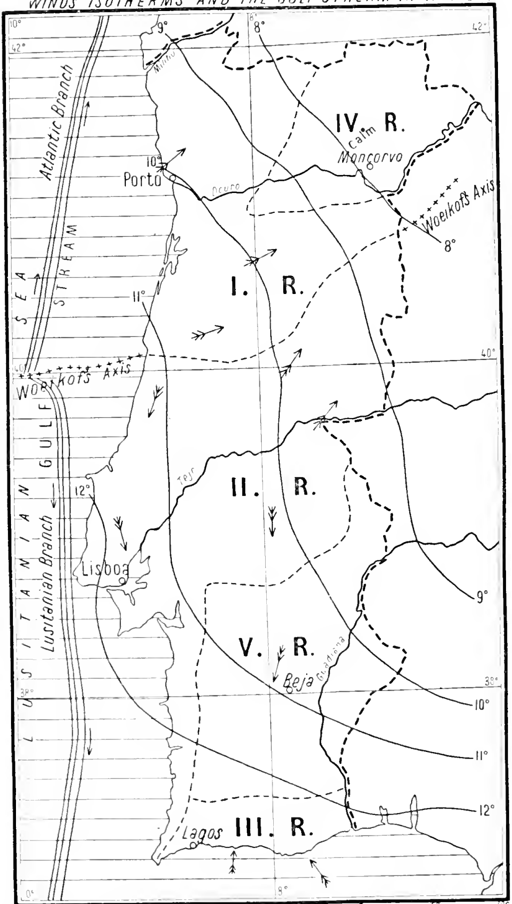
Map III.. PORTUGAL.

WINDS ISOTHERMS AND THE GULF STREAM IN WINTER.



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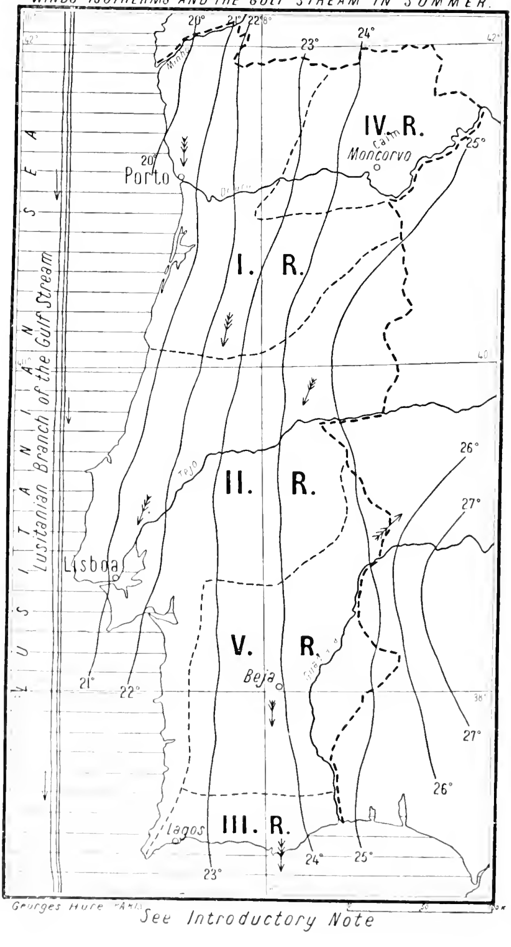
Map IV. PORTUGAL.

WINDS ISOTHERMS AND THE GULF STREAM IN SUMMER.



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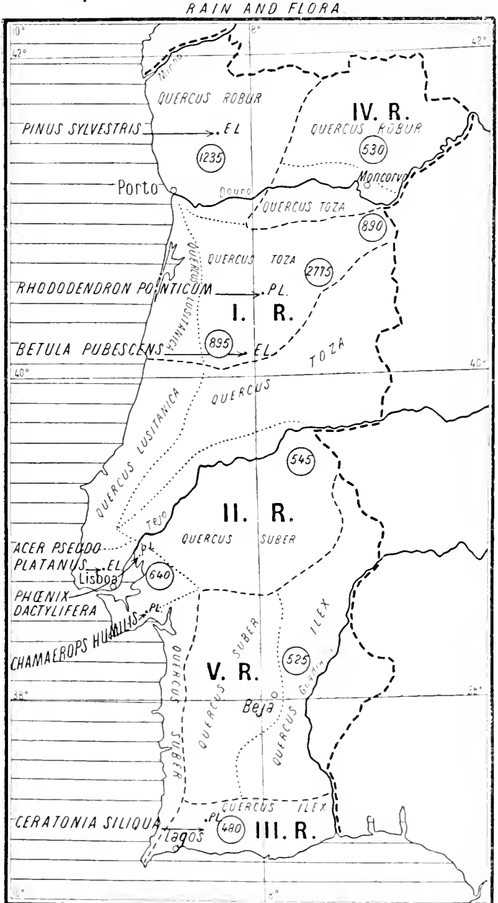
Map V.. PORTUGAL.

RAIN AND FLORA



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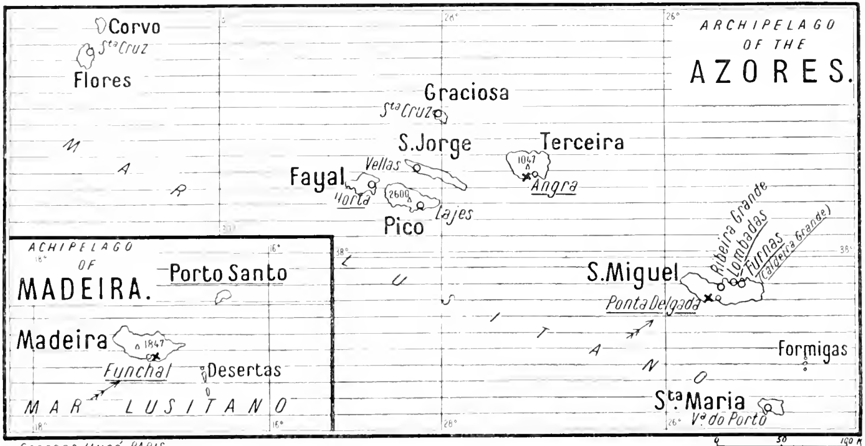
Map VI.. PORTUGAL.

THE ACHIPELAGOS OF THE AZORES AND MADEIRA.



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